MECHANICAL ENGINEERING

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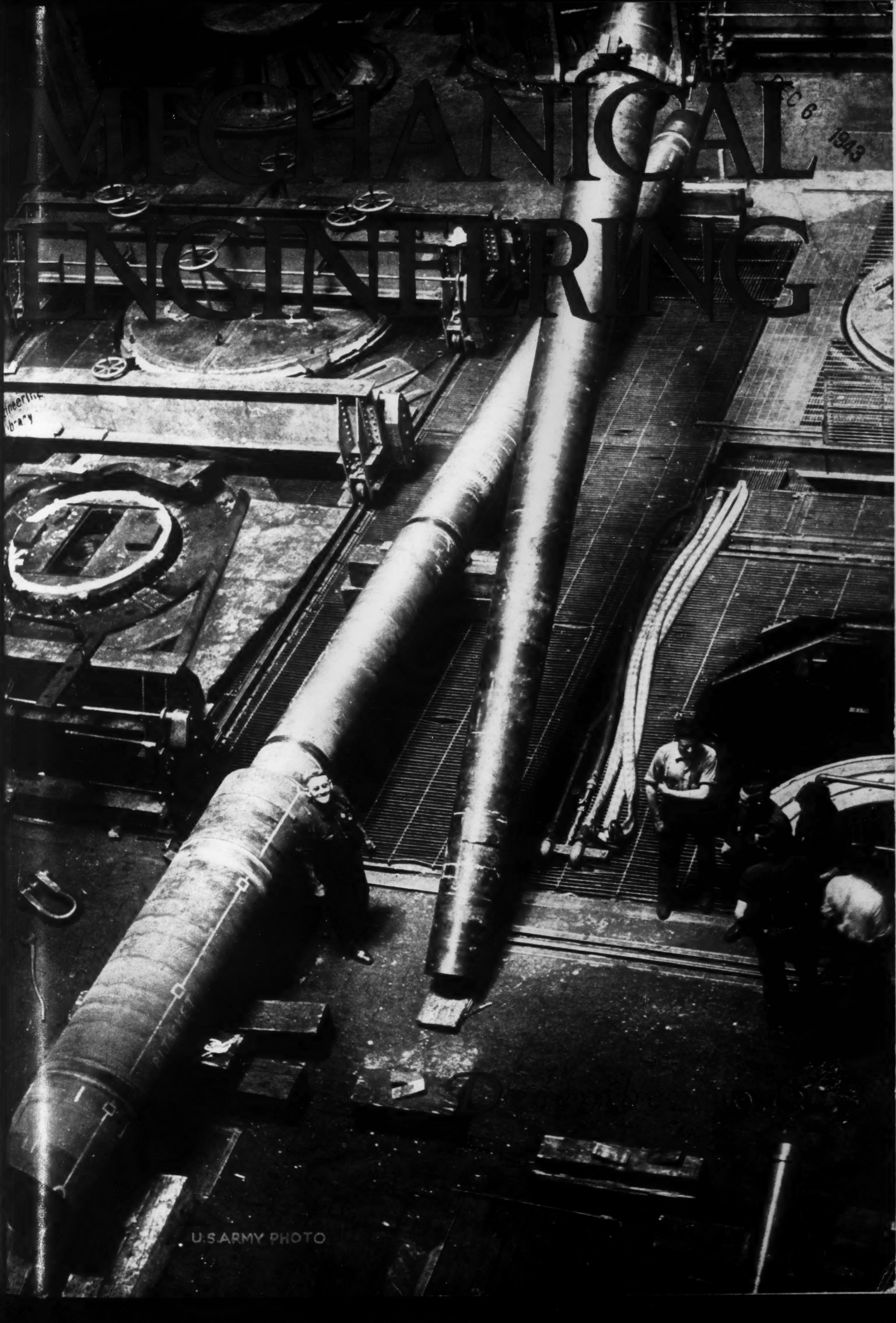

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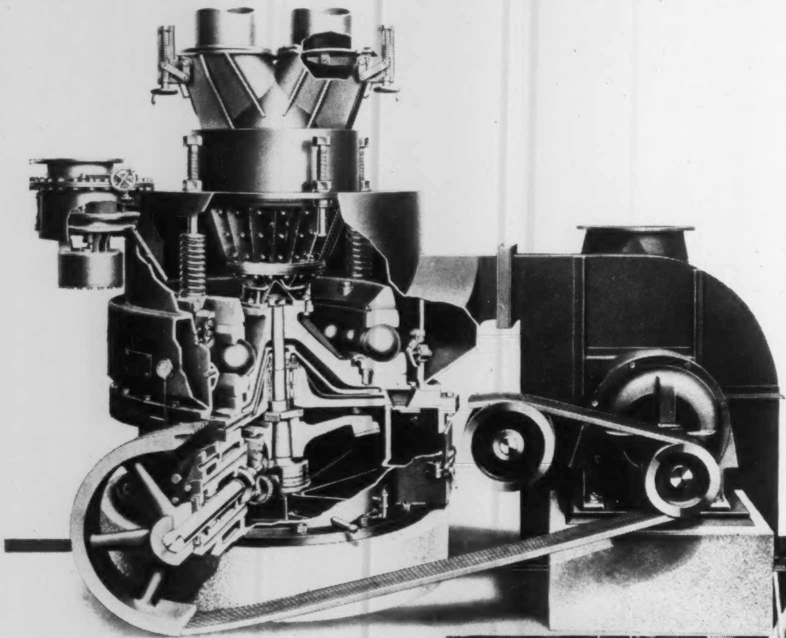
G256



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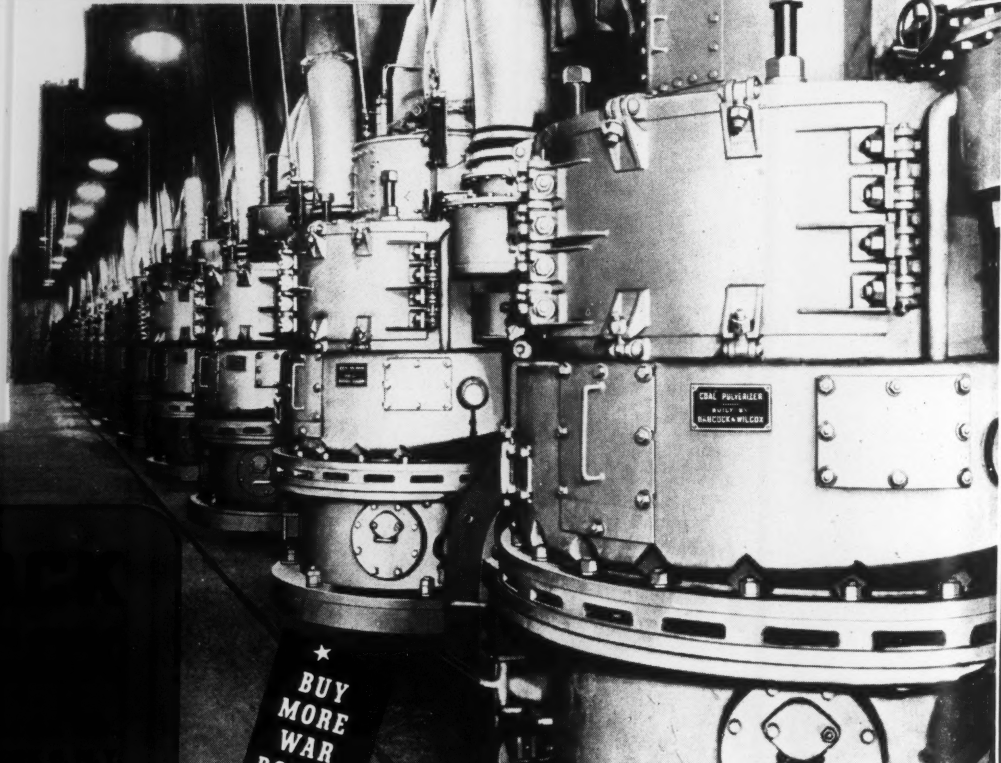

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MECHANICAL ENGINEERING

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VOLUME 65 NUMBER 12

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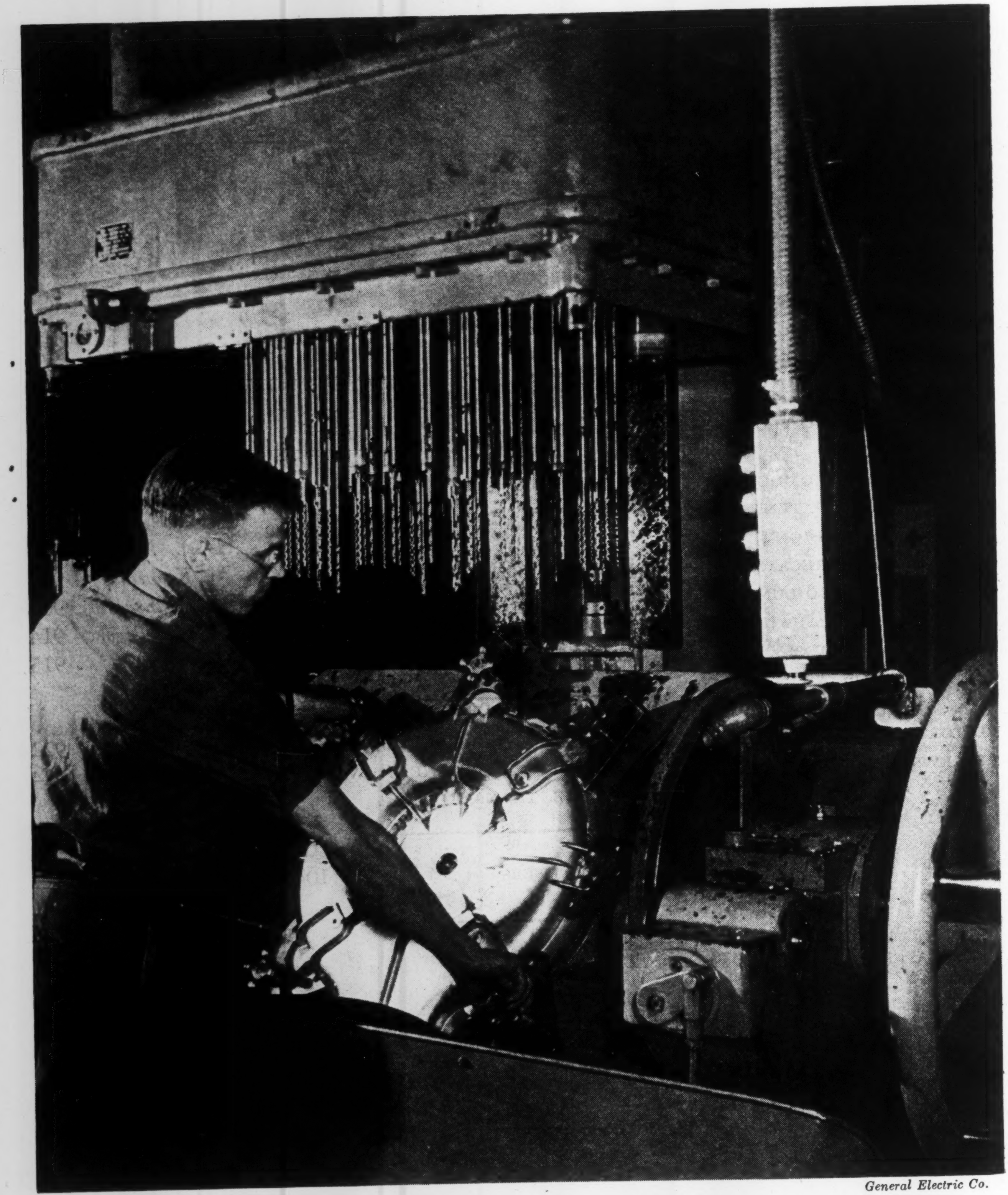

General Electric Co.

Fifty-Two Holes With One Drilling

Volume 65
No. 12

MECHANICAL ENGINEERING

December
1943

GEORGE A. STETSON, *Editor*

Why Join a Society?

IN peacetime a majority of engineering-college students are planning careers in engineering and industry. Through their student branches the engineering societies reach out into the engineering colleges to help prepare these students for the period of transition from academic to professional and business life. By making available to the young graduate a junior membership they afford him an opportunity for professional fellowship and self-advancement.

At present and in a majority of cases the natural transition of the student from academic to professional life is being interrupted by the war. Some graduates will be fortunate enough to be placed in situations where their engineering experiences will develop their professional growth. Many others will not and instead they will find their engineering careers seriously handicapped. In either case uninterrupted affiliation with the professional engineering society serving the field of engineering which they have prepared to enter will be of real value when these students return to civil life and need the support and inspiration of professional fellowship.

The reasons for joining professional engineering societies do not change although they may be more compelling under some circumstances than under others. Prudent planning on the part of engineering students now in college should not lose sight of the after-the-war advantage of uninterrupted affiliation with a professional engineering society. In order to give the student something to think about, Mechanical Engineering is reprinting in this issue, page 900, an article written by D. C. Jackson, professor emeritus of electrical engineering at the Massachusetts Institute of Technology, that appeared originally in *Tech Engineering News*, November, 1927. The arguments adduced by Dr. Jackson are even more compelling today than they were in 1927.

New A.S.M.E. Committee

AT its October meeting, as reported in this issue (page 928), the Executive Committee of the A.S.M.E. Council appointed a new committee to deal with the Society's program for postwar planning. In order to reassure members of the Society that the project is in competent hands, it should be stated at once that the chairman of this committee is E. G. Bailey, vice-president of The Babcock and Wilcox Company, and the members are Ralph E. Flanders, president, Jones and Lamson Machine Company, engineer and writer on economic subjects, chairman of the committee on research of the Committee for Economic Development; W. L. Batt, vice-chairman of the War Production Board, president, SKF Industries, Inc., past-president and honorary member, A.S.M.E.; R. E. Doherty, president, Carnegie Institute of Technology, already engaged in postwar planning activities in the Pittsburgh area; and David C. Prince, of the General Electric Company, who, as president of the American Institute of Electrical Engineers two years ago, spent much time in talking to engineers about postwar problems. It would be hard to find among enngineers a group more competent to lead the Society and its members in making themselves active forces in planning for the difficult days after the war.

Paper Shortage

AS in every other area of our economy, a serious situation has developed in connection with the paper that is used by magazine publishers, including the engineering societies. Because of a shortage of paper, the A.S.M.E. publications, in common with others, have been limited in the quantity of paper they are permitted to use to what amounts to 90 per cent of the total tonnage used during 1942. Beginning with January, the amount which the Society will be permitted to use in its regular publications during 1944 will be 75 per cent of the tonnage used in 1942.

The Society has been alert to the need for paper conservation for some time. About a year before paper limitations went into effect, members of the Society were asked, as a conservation measure, to permit the removal of their names from the mailing lists of Transactions and the *Journal of Applied Mechanics* if, for any reason, they were not making use of these publications.

As soon as paper limitations went into effect, the Society studied the situation to see what could be done to decrease use of paper. First, the margins of Mechanical Engineering were trimmed. As more was trimmed from the side than from the end margins, it was found possible to add three lines (six for a two-column page) and still keep the proper proportions of type and total areas. The number of extra copies printed was reduced. Paper stock used was reduced from a 50-lb to a 45-lb base and will be reduced to a 40-lb base. Lighter cover stock was used.

These measures sufficed in 1943, but with the extra cut for 1944, additional economies become necessary. It must be remembered that since 1942 the membership of the Society has been growing steadily and hence the number of copies printed has also grown. In this same interval the engineering schools have changed to a twelve-month year so that student members get 12 issues of Mechanical Engineering yearly instead of eight. Larger meeting programs and more Society activities have increased the supply of articles and other demands for space. How are these new conditions to be met?

At a recent meeting the Committee on Publications reviewed this problem thoroughly and took several actions. It was decided that copies of MECHANICAL ENGINEERING would be issued to student members without the advertising pages. Although the Committee regretted taking this action, it felt that the saving in paper justified the step. A further cut in trim size of the pages of MECHANICAL ENGINEERING was authorized, provided the technical details can be worked out with the printer. It was felt that the limit had practically been reached in reducing the size of the type face and the weight of the paper.

Conscious of the fact that it could not save all the paper necessary to keep within the limitations imposed upon it, the Committee, not satisfied with the cheese-paring devices already mentioned, turned to more constructive ways of solving its problem. A year ago, in anticipation of changes that might have to be made when the war came to an end, the Committee began a study of the possible needs of MECHANICAL ENGINEERING and decided upon an enlargement of the editorial staff that would permit a more thorough editing and condensation of articles than had been possible in the past. It was natural, therefore, for the Committee to look to the editorial staff to help out during the paper shortage by putting this new policy into effect. It instructed the staff to pay special attention to the quality of articles published and to make every effort to see to it that these articles would be more thoroughly edited and condensed. Although the decision in the first instance was not prompted by any desire to save paper but because of the belief that readers prefer carefully edited and properly condensed articles, the foresight in enlarging the editorial staff proved a double blessing at this time of paper shortage. The task of carrying out the policy will not be an easy one and co-operation will be needed in order to put it into effect. The Committee is confident that members of the Society will approve the policy in principle.

Most drastic of the changes in publication procedure authorized by the Committee, however, has to do with articles for the Transactions. It has been decided to preprint papers for the 1944 Spring and Semi-Annual Meetings directly from the authors' typescripts in a form now used by the American Institute of Electrical Engineers. After the meetings have been held these preprints will be carefully reviewed. Decision will be reached as to which of the preprinted papers are of sufficient value to be used in the Transactions. If the papers chosen for printing are long, the authors will be asked to condense them before they are edited and printed.

This procedure, desirable from many points of view at any time, is particularly desirable and necessary during the paper shortage. It will result in permanent economies and in raising the quality of the Society's Transactions. Here again co-operation will be needed. It will be necessary for authors to be more careful than they have been in the past in the preparation of typescript copies of their papers and of copy for illustrations and tabular matter; and it will be necessary for committees who set up programs and solicit papers for meetings to explain the change in procedure to authors. Again, the Committee on Publications is confident that it will have the backing of the average member.

E.C.P.D. in the War

ONCE more the Engineers' Council for Professional Development has met and once more it has demonstrated to the small group of engineers and educators who were priviliged to attend its annual dinner what men of vision and practical idealism are trying to accomplish for the benefit of the engineering profession and engineering education.

A brief report of what wartime conditions have meant to E.C.P.D. will be found in this issue. It reveals that the program of the Council and the men who direct it are virile enough to meet changing conditions without altering ultimate goals. Marked progress is being made in an attempt to find reliable yardsticks for measuring the apptitudes of young men who wish to enter the engineering colleges. Accreditation of engineering curricula has been practically suspended owing to war conditions, but the interest of E.C.P.D. in maintaining high standards in the schools is unabated. Plans for aiding young men in the profession are being expanded and revised, and a manual for junior engineers is in preparation. One of the constituent bodies, the American Society of Civil Engineers, is making a vigorous effort to assist its younger members who may become involved in collective-bargaining procedures. The educators are keenly alive to the challenge and opportunity of the postwar era and have a progressive outlook on educational objectives and ways to achieve them. Granted the support and intelligent interest of the engineering societies and of the industries and other employers who utilize engineering-college graduates, these men will make noteworthy contributions to the life of the nation after victory has been won. Threatened shortages of trained engineers and the problem of what to do with men who have been inadequately trained will require the utmost in co-operation on the part of the schools, the employers of engineers, the engineering societies, and the men to be returned to civil life. E.C.P.D. can be a guiding influence in co-ordinating efforts in this area.

One of the handicaps under which E.C.P.D. labors is that it lacks the direct contact with thousands of engineers that would be possible with an individual-membership association. E.C.P.D. establishes policies for joint action, but the carrying out of these policies must be done by the several constituent bodies. Some organizations have disintegrated because of lack of direct personal contact between the organization and the men that are being benefited. The leadership of wise and able men is likely to be dissipated by passing through too many channels of communication. It is heartening, therefore, that the Council has seized upon the Fairman plan, which affords an opportunity to bring the program of E.C.P.D. to every engineering group in the nation. E.C.P.D. will soon issue a pamphlet, "Will You Help?" prepared by a committee of which Mr. Fairman is the chairman. The pamphlet is a manual of information and instruction for local groups of engineers all over the country who wish to carry on the work of E.C.P.D. in their own communities. Successful operation of the plan will not only hasten attainment of E.C.P.D. objectives but should also prove a practical device for enlisting the interest and support of thousands of engineers for its program.

MANPOWER UTILIZATION *in the* UNITED STATES

By LAWRENCE A. APPLEY

DEPUTY CHAIRMAN AND EXECUTIVE DIRECTOR, WAR MANPOWER COMMISSION, WASHINGTON, D. C.

MANPOWER utilization in the United States is at this time in the stage of definition, identification, and programing. Outstanding leadership in this field is being supplied by the Bureau of Manpower Utilization of the War Manpower Commission.

While the Bureau of Manpower Utilization furnishes leadership in this field, by far the greatest amount of actual utilization work is done within industry itself by management and labor. Other government agencies, closely identified with production facilities, render varying types of assistance.

At this point in the manpower-utilization program we are in the consulting rather than the inspection stage. The ever-increasing stringency of the labor market, as well as the speed with which industrial management increases its own activities along this line, will determine whether we have to enter the inspection approach to this question.

MANPOWER UTILIZATION DEFINED

Utilization can be defined as follows: Utilization means the most productive use of the minimum amount of labor necessary for production under working conditions that will maintain worker effectiveness and morale.

When this conception and definition of responsibility are thought through, the extent of the obligation will plot an area of large size. It includes the best use of industrial, agricultural, and government personnel. It means that each person, male or female, who is physically able to render personal service, shall be given the opportunity to serve in an essential capacity; exert his or her particular abilities in a sustained and unrestricted way on a schedule of hours and under working conditions consistent with good health and morale. Actually no worker is left out of this total war enterprise. Obviously, utilization involves all the factors that affect workers in the performance of their productive effort. It is immediately apparent what some of these factors are—Plant conditions, production procedures, personnel policies, and out-plant conditions. In fact, a list of the various elements of these major categories affecting manpower utilization needs to be set down. We shall include such a basic-factor list in connection with the program plan of action.

Lest we become casual in considering utilization, we should recognize that we are now seriously underutilized all along the manpower front. This is the consensus of opinion of management, labor, and of independent observers.

When in an airplane factory over 30,000 employees have been added to the pay roll in one year, and yet at the end of the year there are 400 less employees than at the beginning, we can understand the enormous utilization wastage of turnover.

As to "absenteeism," in one large company, it was found that the rate of absenteeism was such that 1500 additional workers had to be kept on the pay roll in order to meet the production schedule.

On the other hand, when a shipyard in a period of 9 months can cut the man-hours on a Liberty ship from 900,000 to 250,000 hours, we get some idea of the contrast between underutilization and utilization. We gain an insight on what manpower utilization means.

When a plant, by improved production procedures, can turn out 35 per cent more work with 25 per cent fewer workers, we get an idea of what proper utilization can do and is called upon to do.

From these illustrations, it is clear that the utilization job has got to be done at the local level, where the plants, factories, and industries are located, and it is the combined job of Government, labor, and management

The utilization job requires a plan of procedure to acquaint management not only with the manpower-utilization services of the War Manpower Commission but a plan of publicized information on utilization that will enlist the co-operation of management and labor in undertaking utilization improvements.

Let us now translate this general job statement into a utilization program at the local level, as follows:

1 DETERMINATION OF UTILIZATION NEEDS IN AREA

The primary indicators of need are as follows:

1 Unplanned Selective Service withdrawals, and relation to "manning tables."
2 Production lag and production rate per man-hour.
3 Excessive turnover.
4 Excessive absenteeism.
5 Unusual labor-recruitment problem.

Effective utilization of manpower is so big a job, with so many sides to it, that we must organize our attention on the larger issues first. That being so, we can pick out what are the primary indicators of inadequate utilization. They are such things as unplanned Selective Service withdrawals, production lag, and low production rate per man-hour, excessive turnover, absenteeism, and unusual labor-recruitment problems.

Notice that these primary indicators are not the causes, but the effects of underutilization. They are the signals of need. There are other signs, too, such as frequent complaints of workers at the employment center. Also, threatened strikes and serious accidents are evidences of need, but these latter are dramatic items that are headline news and could not fail to provoke attention. But, in the ordinary day-by-day treadmill of war effort, we can expect to find need for a utilization job wherever military withdrawals are irregular, where production is behind schedule, where turnover and absenteeism are excessive, or where there are serious labor-recruiting problems.

It would seem to be a matter of common sense that on account of the hurried pace of war production, we have to think in terms of greatest needs first. Of course, we have to do an over-all educational job, too, and do it concurrently, but we shall deal with that a little further along.

Our situation is somewhat analogous to an epidemic of influenza. It may be that the general health of the populace is below par, and that this contributes to the rapid spread of the disease. The medical job is, of course, a dual one. It must treat the sick, and it must conduct a health campaign in the press to get as many as possible to help themselves and keep well. The physicians, however, will be giving their skilled

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Presented at a Joint Meeting of The Engineering Institute of Canada and The American Society of Mechanical Engineers, Toronto, Canada, Oct. 1, 1943.

attention to those in greatest need. In like manner, our consultants are out there in the area dealing with the most pressing cases of need. The training and placement personnel are an indispensable auxiliary force. At the same time, a general health campaign is under way. We shall presently make suggestions for the health campaign. The epidemic we have to deal with is underutilization, and the utilization program is the health program to meet that condition. The whole enterprise is under the operational direction of the area director.

1 *Selective Service Withdrawals and Manning Tables.* One of the very first recognized needs for manpower utilization arose in connection with Selective Service withdrawals from industry. A technique was needed that would prevent undue dislocations of worker personnel while at the same time providing for military manpower. That technique is now well known to everyone as the "Manning Table and Replacement Schedule" procedure. Its usefulness as an instrument in connection with other phases of utilization is significant. However, it should be mentioned here that the Selective Service phase of the utilization job is not at all finished. The work along this line must continue. It is well to add here this further comment: That the assistance rendered and being rendered to management in the preparation of manning tables by Bureau of Manpower Utilization consultants has been one of the outstanding parts of the civilian war effort. As of June, 1943, manning tables for more than 6000 factories, shipyards, and other work places have been prepared or are in process of preparation.

We may expect to find in connection with this work that after the replacement schedule is made out, some employers will say that they cannot meet its replacement demands. This condition is becoming quite common. Responsibility for additional utilization service is thus called for. We may regard this as a further extension of the manning-table project.

Though the manning-table plan has of necessity occupied a predominant place, we are all aware that the utilization program branches out in several directions. As we shall see, the manning table will continue to be a useful part of utilization.

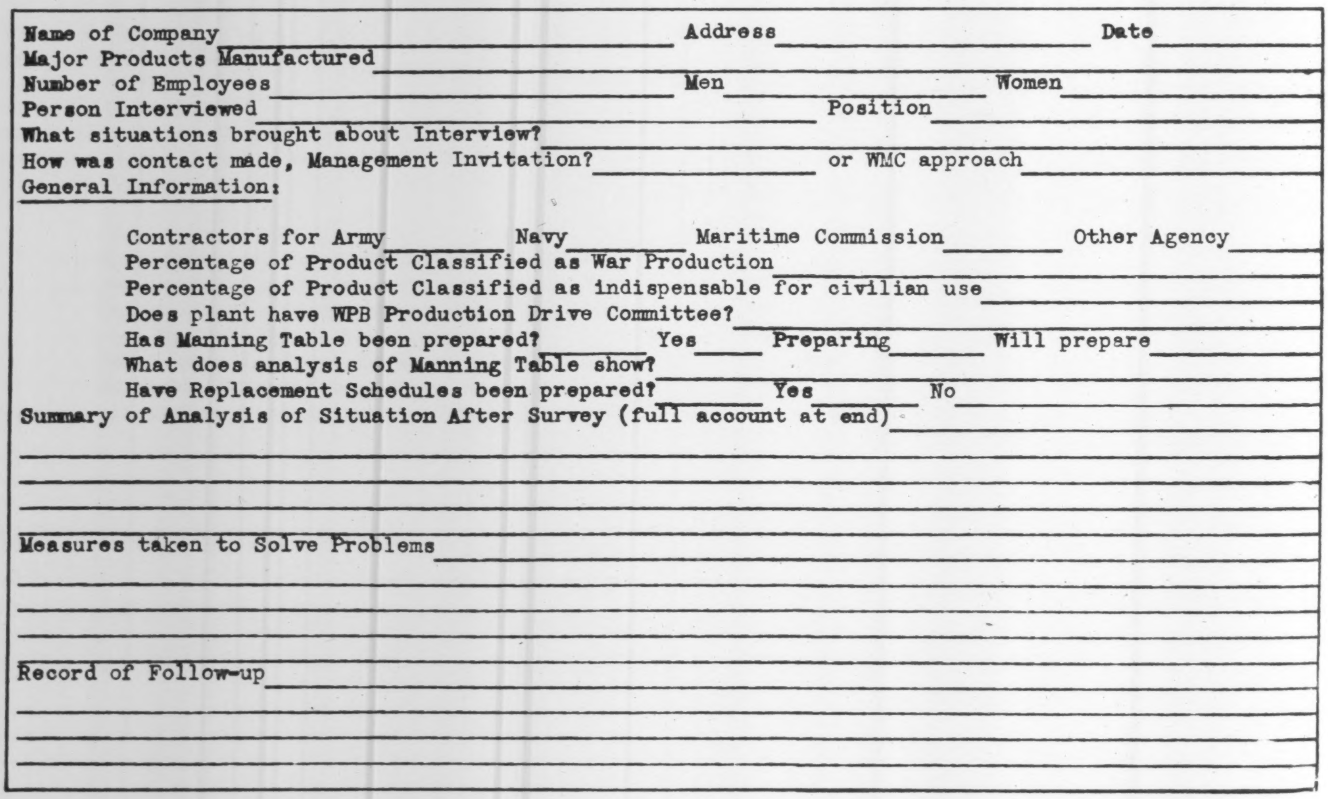
2 *Production Lag and Production Rate per Man-Hour.* In the case of "production lag," we know that factors outside of our responsibility may be operating, such as lack of material and equipment, but nonetheless, production lag is a danger signal and should not be ignored.

How do we know what constitutes production lag? The answer to this question would be very easy if all war-production plants had a production schedule. All the major shipyards, aircraft, and auto factories have, but many companies have no such schedule, and this is especially true of the subcontractors. No doubt, as time goes on, it will be possible for most businesses to set up production goals. However, we are not without recourse in getting at production lag.

In cases where there are production schedules, production percentages are available from information supplied by the War Manpower Commission's Reports and Analysis Service, and also from procurement agencies of the Government. One caution should be brought out here, and that is, that the 100 per cent fulfillment of a production schedule is not proof that the best utilization is taking place. Production schedules were set quite arbitrarily as "best guesses." Recently one very large aircraft plant that was up to 100 per cent production made a utilization survey, and found that it could maintain that production with 1400 fewer employees.

In factories without production schedules, it will be necessary to depend upon estimates derived in various ways, from the plants themselves or from production-drive committees and the like.

We have just talked about production lag in terms of production in relation to schedules. But in the last analysis, utilization is greatly concerned with the most effective productivity per unit of man-hours. Is every man in this and that plant getting the most production out of the skill and effort expended? This question does not imply that the worker should "speed up" or use up twice as much energy to squeeze out more and more production. The question is, how can we use the same energy most effectively? The key to utilization, as



SUGGESTED CHECK LIST FOR INDUSTRIAL CONSULTANTS—UTILIZATION SURVEY

Name of Company Address Date
Major Products Manufactured
Number of Employees Men Women
Person Interviewed Position
What situations brought about Interview?
How was contact made, Management Invitation? or WMC approach
General Information:

Contractors for Army Navy Maritime Commission Other Agency
Percentage of Product Classified as War Production
Percentage of Product Classified as indispensable for civilian use
Does plant have WPB Production Drive Committee?
Has Manning Table been prepared? Yes Preparing Will prepare
What does analysis of Manning Table show?
Have Replacement Schedules been prepared? Yes No
Summary of Analysis of Situation After Survey (full account at end)

Measures taken to Solve Problems

Record of Follow-up

UTILIZATION FACTORS—CHECK LIST

Production Output			
Present percentage of assigned schedule..........................			
Production trend, increasing....... decreasing.... same..........			
Any obvious, clearly defined reasons for decreased or slow production, such as -			
Lack of Materials................ Inadequate labor supply....			
Absenteeism.................. Turnover......................			
Strikes................... Management changes................			
Production Methods			
Production planning..			
Routing and Scheduling of work.............................			
Production records...			
Interest in Improved Methods...............................			
Plant Conditions			
Layout....................... Equipment........................			
Safety....................... Lighting.........................			
Sanitation................... Lunch facilities.................			
....			
Absenteeism			
Percentage of....... Increasing....... Decreasing................			
Any immediately obvious reasons for........................			
....			
Turnover			
Percentage of....... Increasing....... Decreasing................			
Any immediately obvious reasons for........................			
....			
Hiring Practices			
United States Employment Service...........................			
Selection at Plant...			
Physical Examination.......................................			
Any Evidences of Labor Hoarding............................			

applied to productivity, is the phrase, "most effective effort," including most effective use of time. Time is frequently lost through delays of various kinds. Competent observers among the workers themselves concur with production men that the most effective use of the same effort now expended could increase production a very appreciable degree.

One problem before us is: How can we obtain the information which will indicate the red signal of need? As in the case of production lag, some plants have carefully worked out production rates per man-hour. Even in these cases, management can do a great deal more in bringing about an improvement by restudying the situation. One of the best approaches to this problem is through the acquisition of comparative production figures per unit of manpower of plants doing the same kind of work.

An effort is being made to investigate the possibility of supplying data on this problem. Contact is being made with various government agencies to discover reliable sources of information that could be obtained in the field, or passed along to the "area consultants."

3 *Turnover.* The turnover situation is extremely serious, and it has become a major utilization problem. As an indicator of underutilization or misused manpower it has moved up to front-page news.

The utilization consultant has available in the Area Director's office many facts about turnover in the area. The new Form ES-270[1] use of which began July, 1943, contains the information. This report gives not only total monthly turnover, but a separate report on turnover among women employees. The ES-270 form, and the manual of instruction that goes with it, should bring order and definition to the reporting practice on a monthly basis which has been established for all government agencies. There is a turnover report available for every war-production plant with 200 or more employees.

When we speak about turnover, we should mean monthly turnover. The monthly turnover percentage is derived by the following formula:

$$(\text{Monthly plant turnover}) = \frac{(\text{Total of separations during month})}{(\text{Average of working force}^2 \text{ during month})}$$

Of course, the same formula can be applied to departments within a plant, by doing the same thing with the department figures. If desired, the turnover by occupations may be similarly derived by taking occupation figures.

The question may be raised, granted that we know how much turnover there is: How do we know what constitutes excessive turnover? Turnover in peacetime is between 2 and 3 per cent, and it varies for different industries; this is usually accepted as a peacetime norm. In wartime, it is much more difficult to say what a normal turnover percentage should be because, in the nature of war conditions, there must of necessity be many separations and accessions. Right now the average turnover for the country as a whole is slightly over 7.5 per cent. In some places, it is as high as 20 per cent and more. Obviously, the latter is too high, but what shall we call the wartime norm? We simply cannot fix it precisely without being arbitrary, but we can be practical and say that anything over 5 per cent is dangerous. We do want it as low as possible, and we should be on the alert to observe whether there is a trend in one direction or another.[1] In any case, we can arrange our priority list so that a glance will indicate the higher percentages as urgent cases.

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[1] ES-270 shows "employment trend" for each plant anticipating the trend for a 6-month period beyond the current month under four classifications: All employees, women, nonwhite, and part-time.

[2] The "average working force" may be found by adding together the total employees at the beginning of the month and the total employees at the end of the month, and dividing the sum by 2.

4 *Absenteeism.* The fourth indicator of underutilization is absenteeism. In spite of wide publicity, it continues to be disturbing.

Let us understand first what "absenteeism" is, because the word has been loosely used.

"Absenteeism" or "job absence" is defined as the failure of a worker, who is on the pay roll, to appear on the job when he is scheduled to be at work and work is available. This is a standard definition commonly used by government agencies. The definition can be further clarified, however, by noting that an "absence" means a whole day or "man-day," as it is called.

The percentage rate of absenteeism is computed on a monthly basis according to the following formula:

$$(\text{Plant monthly absentee rate}) = \frac{\begin{array}{c}(\text{Number of absences during month, or}\\ \text{man-days lost})\end{array}}{\begin{array}{c}(\text{Total number of employees scheduled}\\ \text{for employment during month})\end{array}}$$

As in the case of the "turnover" formula, a department absentee rate may be computed by restricting the numbers to department figures.

In peacetime, absenteeism may go as high as 9 per cent in certain industries, but the average is about 5 or 6 per cent. In time of war, the average is higher and, at present, it is approaching 8 per cent for all industries. In some war industries it is higher still. The practical view is that any absentee situation which goes above 5 per cent has moved into the red and should be investigated. It should not be too difficult to list the more serious cases which require consultant service.

Facts regarding absenteeism are, as in the case of turnover, obtainable from the new Form ES-270.[1] This report shows total absenteeism and then separately it gives absenteeism for women workers. In addition to this, it shows absenteeism by shifts. This is designed to help locate where the greatest absenteeism occurs which will be of assistance in discovering the causes of absenteeism.

5 *Unusual Recruitment Problems.* The United States Employment Service (U.S.E.S.) is constantly endeavoring to recruit labor to meet industrial demand. It frequently happens that the U.S.E.S. has some question about the legitimacy of the demand. It sometimes appears that these demands are excessive. Are they really necessary? If the U.S.E.S. were to fill the demand in all cases, it would often be required to carry on intensive and extensive recruitment. It will be glad to do so if the labor demand is justified. Where there is a question regarding these apparently excessive demands, the U.S.E.S. would like to have reassurance that the requests are justified. How shall this reassurance be obtained? Logically, if one ignored existing practice, it would seem that at this point the utilization consultant should take over and carry on whatever investigation or survey is necessary at or in the plant to determine the legitimacy of the employment demand. And no doubt the utilization consultant will frequently be presented with this problem by a United States Employment Service office. If so, he may proceed, for it is part of the over-all utilization job.

However, we must take into account existing practice and utilize that practice. Many U.S.E.S. offices have an already established routine for following up on excessive demands. They have regarded the further investigation of the employment situation as part of their function, and they have used members of their own staffs for that purpose. Where this is so, and very competent personnel is available, there is no good reason for disturbing the procedure, and much reason for retaining it. After all, there are so many more employment offices than area offices, that the coverage is much greater. Then again the U.S.E.S. has been in business a long time. It has a well-trained staff, and it has many excellent contacts with various business enterprises. These valuable assets are part of the total strength of the War Manpower Commission. The Bureau of Manpower Utilization does not wish to suggest that the U.S.E.S. let up on any of the valuable services it has been rendering. On the contrary, it is regarded as a very important ally. Organizationally a distinction has been made between "placement" and "utilization," but the distinction is not a wall. In practice the services merge at many points.

Returning for a moment to the question of special recruitment problems as an indication of utilization need, we call attention to a few more of these problems. There are cases where the demand for new workers is not too great in terms of numbers, but too high in terms of skilled workers asked for. Quite possibly a job-breakdown analysis might solve this situation. Then again, the recruiting problem may be one where workmen are unwilling to take employment in certain industries because of known in-plant conditions. Another situation that is now appearing is the number of requests for "statements of availability," and likewise appeals cases. These are all indicators that something is wrong somewhere.

From the standpoint of utilization, it is very clear that abnormal demands for workers is an indicator of underutilization of genuine significance; therefore this item has been featured as one of the primary indicators for which to be on the lookout.

In regard to all of these items included under the heading, "The Primary Indicators of Need," it is fortunate that we have ample facilities for getting information on most of these various points. Additional items of information may, as we have said, turn out to be leads, but the usual ones are indicated here. Because of these indicators, we are able to classify industries in a given area according to utilization need.

II PLAN OF ACTION TO SUPPLY URGENT UTILIZATION NEEDS

(a) The Manning-Table Procedure. The "manning table" is an important part of utilization procedure. It is still desirable that industrial establishments be encouraged to make manning tables, not only as a tool essential to orderly Selective Service withdrawals, but also when it appears to be essential for solving other manpower problems.

The program of utilization will be recognized as emphasizing the term, "utilization survey." We wish to state that the survey is not something utterly new, nor is it diversed from the manning-table procedure. In order to make a manning table, something in the nature of a survey must be made, yet to make it does not necessarily require all that we are now envisaging in a utilization survey. On the other hand, it is possible to make a utilization survey without making a manning table. But in this latter case, a great deal of the same information will have to be acquired which would be already in hand had the manning table been made.

Aside then from the Selective Service aspect of the manning table, the table remains a useful and available tool of utilization. But it is not a "must" in all utilization plant services. We may do either a survey or a manning table, or we may do both, depending upon the local situation and the discretion of the area staff.

(b) Basic Factors of Utilization. At this point what do we know? We know that we have a number of more or less serious cases of underutilization in the industries of the area. We do not yet know the causes of these conditions, except in the case of Selective Service withdrawals. The utilization needs of the area are established for us by our priority list of needs.

In order to set up a plan of action to meet the need by locating the causes of underutilization and removing them, it is of the utmost importance that the consultants have a thorough understanding of just what it is that utilization is concerned with.

UTILIZATION INFORMATION COMPILED FROM CONSULTANT INTERVIEW

Training		Satis-factory	
Pre-employment..			
Apprentice..			
In-plant..			
Provision for training Women......... Handicapped.............			
Upgrading and Transfer			
Job Analysis			
Worker Analysis			
Hours of Work............... Days Worked.......................			
Wage Structure			
Bonus or Incentive Plan			
Union Status and Union Agreements			
Use of Women			
Percentage........... Could use more..... Supply Available.....			
Use of Minority Groups			
Percentage......... Effect of this factor on other workers....			
Use of Handicapped Workers			
Percentage.......... Could use more.... Yes..... No............			
Supervisory Organization			
Overstaffed....... Understaffed....... Clearly defined.........			
Personnel Procedures			
Records.................... Size of Staff......................			
Personnel Policy...			
Termination Interviews			
Recurring reasons for quits....................................			
Employer - Employee Attitudes			
Attitude of Labor toward Management............................			
Attitude of Management toward Labor............................			
General Impression of Employee Morale			
Outplant Factors			
Transportation...			
Housing..			
Recreation...			
Health Facilities..			
School and pre-school..			
Community attitude and responsibility..........................			

What are the possible causes or factors that make people quit their jobs or take days off or that slow them down? What are the conditions that retard or bring about a decline in the production rate? The possible reasons are well known to specialists in the fields of production engineering and personnel management. The reasons or causes cover a wide range of possibilities, any one of which, or any combination of which, may be operative in a particular plant. That is to say, if we could have a kind of master list of these causes, or even a list of the most common causes that make for ineffective utilization of manpower, we could survey a factory in terms of this list and locate what it is that is causing the difficulty.

Such a list of basic factors has been prepared as part of the utilization-survey list. It contains a breakdown of the elements usually classified under the heading of "plant conditions," "production procedures," "personnel policies," and "outplant factors."[3] We shall discuss the functions of this list in a moment, but here we wish to say that such a list contains the common recurring characteristics of items that affect manpower utilization. Any industrial organization that could rate itself or be rated "good" on all these items would be a very outstanding business, with a very low percentage of absenteeism and turnover, and a high rate of production per man-hour. That company would have a healthy or sound utilization program as part of its management policy.

We now know two fundamental things, (1) the utilization needs in our area, and especially the cases of most immediate need; (2) what utilization is. We know from the study of the utilization-survey list the factors or constituent elements of utilization. We know now what the pulse rate and the temperature of the business enterprise should be. The next step will be the actual contact at the plant.

(*c*) *Procedure for Making Contact With Management.* Having selected a prospective establishment for interview, a procedure is necessary. It is not the intention to provide the consultant with a stereotyped sales talk in undertaking his contact. It will make some difference regarding the character of the approach whether the consultant was invited or came of his own accord, or whether the factory experience with manning tables was satisfactory or not. Some general considerations, however, regarding approach may hold for most cases. And these suggestions are equally valid, whether the consultant makes his contact in the interest of getting a manning-table acceptance, or whether it is a more extensive utilization survey that is in view.

It should be an axiom that contacts must be made with the highest operating official in the company. We should not go in except through the top man. The interviewer should have a good deal of knowledge of the corporation in question. Presumably he knows about its production, turnover, and absenteeism. If there was a manning table prepared, he knows a good deal more.

Let us assume that the object of the interview is agreeably to induce management to allow the interviewer to make a utilization survey. We already know there is need for utilization improvement, and in all probability, management will be more than ready to co-operate with the consultant who is there to help him supply that need. In such an interview, a skillful and tactful consultant will obtain a fairly good idea of what kind of an organization he has to deal with. Without ever displaying a check list, the consultant should learn during the interview a number of things on the survey list that are most essen-

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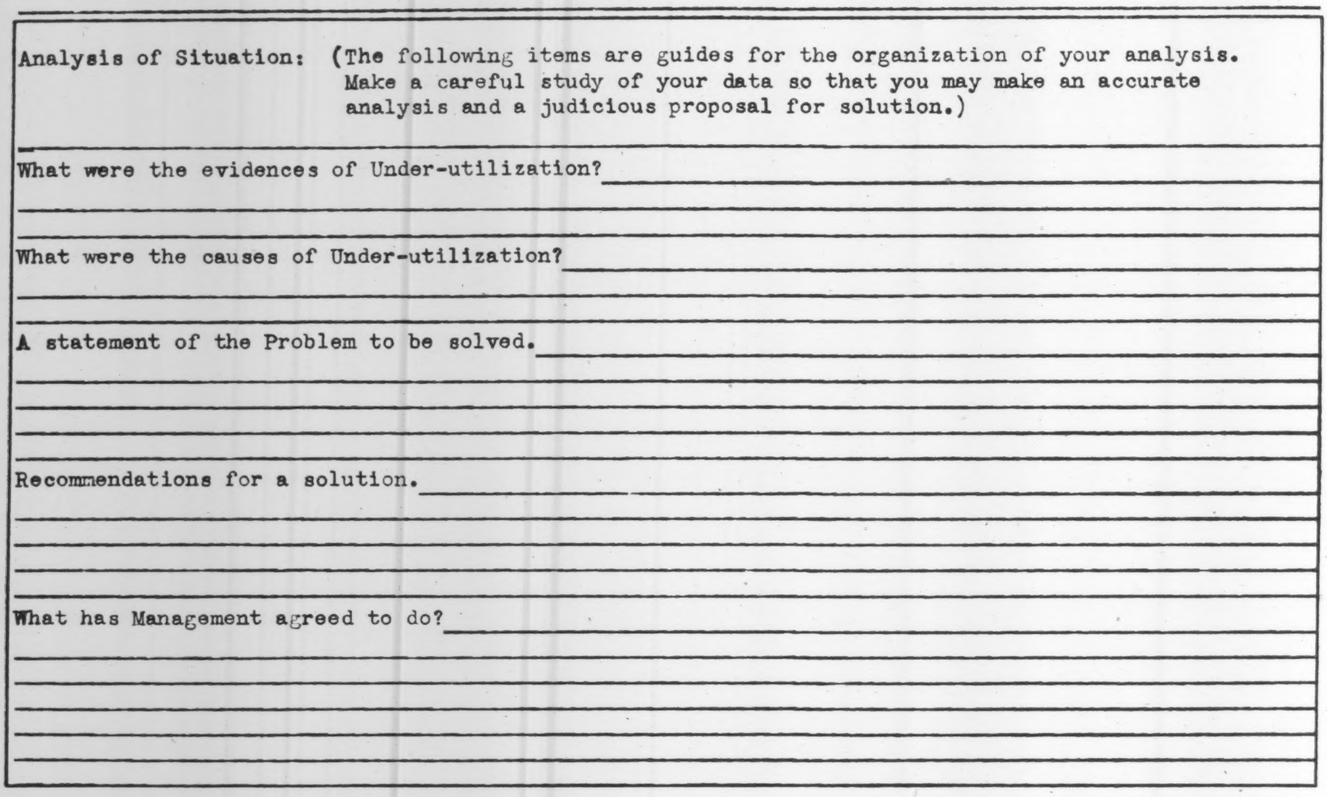
[3] Refer to previous section "Manpower Utilization Defined," or to "Utilization Factors—Check List," one of the illustrations.

ANALYSIS OF UTILIZATION FACTORS AND RECOMMENDATIONS



Analysis of Situation: (The following items are guides for the organization of your analysis. Make a careful study of your data so that you may make an accurate analysis and a judicious proposal for solution.)

What were the evidences of Under-utilization?

What were the causes of Under-utilization?

A statement of the Problem to be solved.

Recommendations for a solution.

What has Management agreed to do?

tial to know, i.e., the personnel policy of the company, the size of the staff, the attitude of management toward labor, hiring practices, attitude toward minority groups, use of women, wage structure, and so on. These first impressions can be confirmed or qualified later, but the initial interview should be on a high level. It should be conducive of mutual respect, laying solid ground for the later interviews in which the recommendations for dealing with the situation are to be presented.

We should not forget at any time the human-relation aspect of the interview. Management frequently has a defensive frame of mind toward government men and understandably so. In the first place, executives have reason to think they know how to run their own businesses. They have pride in their organization, and they may resent the implied criticism of our presence. In the second place, they may have had some unpleasant encounters with other government representatives. They may think they would be in better shape now if it were not for "all this government interference." We are not concerned with the merits of this attitude. We are concerned to remark that the wise consultant will take it into account and understand it. Perhaps he may dispel it by his own judicious approach. Management needs to be reassured that this is not some government investigation that is about to take place. We are not going to collect information to be placed on file anywhere. We can, however, render a type of service that is not likely to be supplied by anyone else in the present employ of management. These are all-important considerations. The whole success of the utilization survey may very well be determined by the way in which the approach is made to management. Consequently, we need for this work men who not only have experience, but men who know how to meet people forcefully, but not officiously.

It is conceivable that management would refuse to cooperate at all, but this extremity is unlikely. We have every reason to approach management with the awareness that it is as much interested in winning the war as we are. And winning the war at the plant level is manpower utilization.

(*d*) *Making the Utilization Survey.* Information on utilization factors provided by the manning table includes the following:

1 Total personnel employed.
2 Total hired previous 6 months.
3 Description of the nature of the business concern.
4 List of jobs in the plant.
5 Extent of use of women and handicapped.
6 Percentage of workers in each job.
7 Number of workers in training in each job.
8 Extent of job re-engineering.
9 Extent of upgrading and transfer.
10 Extent of recruiting outside the plant and estimate of maximum labor needs.
11 Recommendations already made to plant for improving utilization on the basis of manning-table findings.

The fact that the manning table discloses so much is an impressive commentary on its usefulness. In fact, in some regions, many of the items in the survey check list are already included as part of the presentation to management of manning-table findings.

The ES-270[1] form also discloses a great deal about a plant. The following information from Form ES-270 will be available in any case whether there is a manning table or not:

1 Employment trend.
2 Turnover percentage for all employees and women.
3 Absentee percentage for all employees and for women.
4 Critical occupational shortages and number needed in these occupations.
5 Anticipated gross labor needs for next 4 months.
6 Anticipated separations for next 4 months.
7 Information regarding recruitment methods, in-plant training, upgrading and job breakdown.

The purpose of the survey list is that it should serve as a guide in locating the causes of underutilization. Much of the knowledge required in completing the utilization survey will be in hand before we get much beyond the main office. The items that remain should be covered through a variety of interviews with the personnel manager, chief production engineer, labor-management committee chairman or members, production-drive committee people, operating supervisors, foremen, workers, and union representatives. The United States Employment Service and training personnel may contribute important items essential to an evaluation. The resident Army or Navy officer or other government personnel should be consulted. Various individuals in the community may need to be interviewed. The circumstances will dictate to the alert consultant various avenues which must be locally followed to gather the pertinent information of the survey.

In order to assist the consultant in gathering his facts, work sheets have been prepared together with accompanying instructional material. These tools will be of aid in getting more detailed information regarding the causes of underutilization disclosed by the preliminary survey. For example, if in the process of making the preliminary survey or check-up it appears that a production-flow bottleneck is the problem, then the special work sheet on production, and the instructional material therewith, will aid the consultant in getting the pertinent facts about production conditions. In other words, the work sheet will enable the consultant to make a more complete survey analysis of the difficulty. Again, if the preliminary check list discloses that a lack of a constructive personnel program is the main cause of absenteeism or turnover, then the work sheet for personnel will be of aid to the consultant in getting more complete knowledge of the personnel deficiency. Thus the work sheets are supplementary to the check list and will enable the consultant more competently to make the utilization analysis.

The consultant having gathered his data, must now study it carefully. No doubt he has seen many things that might well be improved. But the hurried nature of our task compels us to think in terms of the main factors that need improvement. We should isolate these main causes and have a very clear conception of what they are.

Equally important is the necessity of determining what measures would overcome or greatly minimize the causes. It cannot be emphasized too much that this step calls for a very comprehensive understanding of the whole situation, and for some hard thinking.

(*e*) *Recommendations to Management.* All that was previously said about the initial interview with management is also applicable now. It is really harder to present the findings and tell management what is wrong. But there are remedies to propose and that is something constructive. Be able to show what these recommendations will do in this plant if they are adopted. We must talk in terms of consequences that are positive and that can be measured.

(*f*) *Agreement With Management on Measures to Be Taken.* Action must be taken on the recommendations. As a matter of fact, all that may be necessary in many instances will be the presentation of what the causes of trouble are. Alert management will want to do something about this. That is what we hope for. In other cases it may be necessary to press for action to be taken. The agreed upon procedure must be a definite program with specific steps spelled out with a time schedule, and clear delegation of responsibility for carrying out the actions.

III PLAN OF ACTION TO SUPPLY NEED FOR UTILIZATION EDUCATION

It was remarked earlier in this descriptive outline that, in dealing with an epidemic, there are two basic needs which have to be met, i.e., (1) dealing with the immediate cases of illness, and (2) promoting a health campaign to educate the public. The use of the epidemic analogy is not far-fetched. The lack of adequate utilization is a menace to our manpower resources just as real and just as effective as an epidemic would be. It removes as many people, probably more, from productive effort. Therefore, it does become necessary as part of utilization to undertake educational measures. It is not management alone, but labor too, both in the ranks and at the helm, which requires a genuine appreciation of the utilization problem. We must convince labor as well as management that the utilization program does not encroach upon or infringe in any way the real interests of either. There is nothing here that anybody has to be on guard against. False notions about utilization have bobbed up here and there, that utilization is a new kind of regulation of management, that it imposes policies and procedures which management does not like; or from the labor point of view, that utilization means "the speed-up" with all the old-time associations therewith. These misunderstandings are not even close to the facts. Actually, utilization if properly understood is a balanced program of co-operative effort in the common interest. No real values are subtracted from anybody, and yet the common pool of national effort can be enriched thereby.

Clearly an educational effort is called for. It needs to be dynamic. It needs to inspire as well as to inform.

IV ORGANIZATION TO ADMINISTER POLICIES AND ACTIONS

It is plain that at the area level the organization requirements are very simple to state. The organization of the War Manpower Commission has already been determined, and within that organization a place was made for manpower utilization.

At this level the area director has, as a member of his staff, one or more Bureau of Manpower Utilization consultants. The chief consultant directs the works of the other consultants and at all times is directly responsible to the area director.

This program, as now stated, has defined the meaning and extent of utilization, the determination of need, and the manner in which need is to be supplied. In short, the program has tried to make clear what the procedures and actions are that can be completed at the area level.

V ACCURATE MEASUREMENT OF RESULTS

Measuring the Primary Indicators of Improved Utilization. It has already been mentioned with regard to the educational phase of the utilization program that results cannot be measured too precisely. But it should be quite different in regard to our specific plant procedures. We should be able to measure the results of our treatment of specific cases. As a matter of fact, in measuring the results of our efforts, we do something very similar to what we did at the outset when we took note of the primary indicators of underutilization. We look in the same direction where we saw the red signal flags, and we ought to be able to discover something very positive.

1 We should see a smoother flow of Selective Service withdrawals.

2 It should certainly be possible to discover a reduction in man-hours per unit of production.

3 Lower percentages of turnover will give us positive measures of this factor.

4 Lower percentages of absenteeism will give us a positive measure of the extent of improvement here.

5 Lessening of serious recruitment problems at our employment offices will be readily recognized as positive evidence of improved utilization.

The application of this approach supplies the management involved with an accurate measurement of conditions and with a very definite plan of action for correcting conditions of underutilization where they exist. As already stated, this effort is too young to report on its effectiveness. That, however, which has already been done gives us very favorable indications. So far, we have been kept busy answering requests for help. It is reasonable to assume that since this whole effort pulls together many proved methods of sound production and personnel management and focuses them upon a specific problem, that it is assured success.

RAILROAD EQUIPMENT *in* WARTIME

Effects of Peacetime Developments on Wartime Transportation

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IN CONSIDERING the influence of the war on present and future development of railroad equipment, one of the first things noted is that although the war is loading the railroads to the limit of their endurance, it did not find them unprepared. In the last ten years railroad equipment has been undergoing steady growth and improvement. In this, builders and users have participated actively, and the extraordinary demands made by war conditions have shown that their work was soundly done. With relatively small additions to equipment, a tremendously increased traffic is being handled. Net tons of freight hauled per mile of road per day increased from 4800 in 1940 to over 8100 in 1942. Passenger miles in May, 1943, were four times those of 1941.

In general, the effect of the war has been to emphasize the necessity for making the most efficient possible use of existing rolling stock. No great revolutionary changes in design have been produced. New designs have been avoided as far as possible to conserve engineering manpower. The building of new rolling stock has been rather severely restricted and the scarcity of critical materials has necessitated some changes in construction. In car construction, the shortage of steel plates has led to the use of emergency designs with wood taking the place of steel as far as practicable.

IMPORTANCE OF GOOD ROADBED

The present paper in discussing railroad equipment deals more particularly with rolling stock, with the strongest emphasis on motive power, but it must not be forgotten that rolling stock is only one of the legs of the three-legged stool of railroading. A railroad stands firm when its three supports, road, rolling stock, and personnel, are in proper proportion. To many the dynamic locomotive may make more appeal than the static track, but the track is the basis and foundation of railroading. The first public railroad, as we understand the term, the Liverpool and Manchester, was laid out and largely built before the directors had decided whether the trains should be pulled by horses, stationary steam engines, or steam locomotives. The genius of George Stephenson decided the choice in favor of the steam locomotive, and time has approved the decision.

It is fundamental that the civil engineer builds the railroad and that the structure which he provides, the track with its grades, curves, rails, and bridges, has an important influence on how the locomotive engineer finally shapes his machines to handle a given traffic.

One constant aim in railroading is to move more rapidly from place to place. To do this, it is not sufficient for the car and locomotive-engineers to provide easyriding cars and locomotives which can run a few miles an hour faster than their predecessors. Far more can be gained by civil engineering that will eliminate slowdowns than by locomotive engineering that adds five miles an hour to the top speed of the locomotive. The railroads have recognized this and their civil-engineering work in the last ten years has been of great value in carrying the present abnormal traffic.

In the case also of the rolling stock, development work is bearing fruit. The war traffic is not being handled by material which has sprung full-grown from the brains of our engineers. It is being carried by, and is proving the efficiency of, the rolling stock developed during peacetime. New equipment has had to be provided, and more is badly needed, but conservation of time and of the engineering manpower required for new designs has led to reproduction of existing types with only such changes as were made necessary by shortages of critical materials.

LOCOMOTIVE SITUATION REVIEWED

Before going into details, a brief over-all review of the locomotive situation is in order. Three forms of motive power are moving the war traffic—electric, Diesel, and the steam locomotives on which the railroads grew up. All three forms were in active development when the war came. The Pennsylvania Railroad had just completed electrification of 675 miles of the most heavily traveled part of its line, New York to Washington and Harrisburg, and in 1941 was hauling electrically more than 54 per cent of the system passenger mileage and more than 15 per cent of the system freight ton-mileage. The Diesel-electric locomotive had won a prominent place in switching, passenger, and freight service. The steam locomotive, which was handling the bulk of the nation's traffic, was showing active growth in power and efficiency.

Some individual locomotives are considered later in the paper, but before coming to these, some of the basic principles of the three forms of motive power are set forth. All three of them have their proper place in the railroad economy. Some enthusiastic souls who think that we should be modern without being hampered by engineering facts would have us relegate the steam locomotive to obsolescence. Cold analysis does not confirm this view, but supports the warm admiration that many of us have for steam. The most critical study leads to the conclusion that the steam locomotive must be the basic form of motive power all over the world for many years to come.

Differences between electric, Diesel, and steam power lie in the means used for transforming the potential thermal energy of a fuel into effective mechanical work at the rim of the driving wheels.

In the case of the electric locomotive, the energy developed at the driving wheels is generated in a stationary power plant and delivered over an elaborate transmission system. The electric locomotive is all driving mechanism. Tractive force is limited only by the weight on driving wheels. The energy from the line available for traction is practically unlimited so that the amount of horsepower that can be developed by the locomotive is restricted only by the amount of current that the motors can carry without overheating. For short bursts a heavy overload can be carried. This makes the electric locomotive very effective in accelerating a train and in taking advantage of momentum grades. Weight for weight, the electric locomotive can

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out-haul the steam locomotive and the Diesel, but the high first cost of the transmission system limits efficient electric operation to lines of high traffic density. Under conditions such as prevail on the Pennsylvania Railroad between New York and Washington, electric operation carries a volume of traffic which would require additional trackage if steam or Diesel power were used.

The steam locomotive is a self-contained mobile power plant. The thermal energy of the fuel is transformed in firebox and boiler to produce steam. In the cylinders, the thermal energy carried by the steam is turned into mechanical energy which is transmitted directly through the rods to the driving wheels. This driving mechanism provides a very flexible and satisfactory transmission. Loss of power is small and change of speed is simple. In this lies one great advantage of the steam locomotive.

The Diesel locomotive is also a self-contained power plant, but the bulk and complications of boiler and superheater are avoided and the fuel liberates its thermal energy directly in the cylinders. Unfortunately, the internal-combustion engine must run with a narrow range of speed and is therefore not directly adapted to locomotive requirements. To provide the necessary flexibility in speed, complications are necessary. The Diesel cylinders drive an electric generator which transmits electricity to motors geared to the axles.

Comparison of steam and Diesel power is a favorite indoor sport for engineering controversialists. Reams of statistics have been spilled on the subject and more are in prospect. Our present purpose does not require us to be exhaustive or exhausting on the subject. We present only a few facts which seem to be clear-cut.

THE CASE OF THE DIESEL LOCOMOTIVE

A competent engineering authority responsible for the operation of both Diesel and steam power is on record to the effect that no Diesel locomotive is doing work which cannot be done by a steam locomotive. The Diesel is high in first cost, but has the advantages of requiring little water and a comparatively small bulk of fuel. Waterless operation is of advantage in desert country. Conversion of thermal energy into mechanical work is effected with high efficiency so that the weight of fuel to be carried is small. The unit cost of Diesel fuel oil is high, but because of the high thermal efficiency, the fuel cost per drawbar horsepower is not greatly different for the Diesel and the steam locomotive. This relation may be fundamentally affected by war and by postwar developments in the fuel field. The Diesel is necessarily an oil burner and requires a fairly definite grade of distillate. A change in oil conditions which produced a scarcity of this fuel, would hamper the Diesel. The steam locomotive burns coal or low-grade oil and no major change is required to convert from one fuel to the other. Our ample coal reserves insure that the steam locomotive will not be starved out of existence in any foreseeable future.

In comparing steam and Diesel locomotives, a factor to be considered is "availability." The Diesel can be serviced more rapidly and can run a longer distance between refueling so that it is "available" for a greater number of hours a day. However, availability pays dividends only when traffic conditions enable the locomotive to be used during all the hours that it is available. E. E. Chapman of the Santa Fé has pointed out that availability is rather an abstract term as the actual use of both Diesel and steam locomotives is controlled by train schedules.

EXAMPLES OF LOCOMOTIVE USE

Some examples of the use of Diesel and steam locomotives are given.

In the New York Central main-line passenger service, a steam locomotive handles the heavy through trains for the 928-mile run from Harmon to Chicago. Schedules require trains to leave either terminal in the late afternoon and arrive early next morning. That afternoon the run is reversed. The time of layover from morning to evening is determined by the traffic requirements and could not be shortened by mechanical improvements in the locomotive. The steam locomotives in this service make from 20,000 to 24,000 miles a month.

On the Santa Fé, steam and Diesel locomotives handle passenger trains on the 2226-mile run between Chicago and Los Angeles. In steam service, locomotives are changed at Kansas City while the Diesel runs through. Fourteen engine crews handle the Diesel while the mountain-type steam locomotive on the 1789 miles from Kansas City to Los Angeles takes twelve crews. Extended runs of this character are standard practice on the Santa Fé.

Figures given by J. M. Nicholson, assistant to vice-president, Atchison, Topeka, and Santa Fé Railway, show that in regular service engine runs of over 1000 miles are scheduled for four trains daily operated by Diesel locomotives and for 10 trains daily operated by steam locomotives. In such work, the Diesel locomotives average about 18,500 miles a month with a maximum of about 27,000, while the steam locomotives average about 12,400 miles with a maximum of about 18,600. On the Santa Fé as of November, 1942, Diesel locomotives handled 7 per cent of the gross ton-miles of the system and 13 per cent of the passenger-car-miles.

In considering these figures, it should be borne in mind that the Diesel is handling preferred trains and that helper service on heavy grades and protection service against breakdowns is provided by steam locomotives.

In many cases efficient operation is provided by dual-purpose locomotives which can handle both passenger and freight service. An example is given by the 4000-hp Diesel-electric locomotives on the New Haven. These make two round trips between Boston and New Haven daily, one trip in passenger and the other in freight service. The daily run of four times 157 miles is 628 miles, and the monthly mileage is about 15,000.

An excellent example of the usability of steam locomotives is given by the heavy 2-8-8-2 compound Mallets of the Norfolk and Western. Thirty-five of these are operated in a pool out of a roundhouse at Shaffer's Crossing, Roanoke. The average time required to service and refuel these engines between trips in December, 1940, was $3^3/_4$ hours at Roanoke, which is the maintenance point for these locomotives. At the other end of their runs, the time for servicing averaged 2 hr and 45 min. This figure represents the motive-power turning time which is the time the locomotive is out of service because of actual servicing requirements. The total time between runs depends also on train schedules, demand for power, and the availability of crews.

SOME REPRESENTATIVE LOCOMOTIVES HANDLING WAR TRAFFIC

Passing from performance to design, Table 1 has been drawn up to show a number of representative locomotives which are handling war traffic. Table 2 shows three novel designs recently put into service which will undoubtedly influence the future.

Table 1 includes two groups of four-cylinder Mallet articulated locomotives with respectively four and three driving axles in a set. In the rigid-frame locomotives are three groups of two-cylinder locomotives having respectively five, four, and three driving axles. In each group, the various railroads differ somewhat in their choice of leading- and trailing-truck arrangement. In Table 1, the large 8-8-coupled Mallets have in one case four-wheeled trucks front and back, in one case two-wheeled trucks front and back, and in the third a four-wheeled front truck with a two-wheeled trailing truck. Even greater variety of truck arrangement is found in the 6-6-coupled Mallets. The C. & O. engine has a two-wheeled front and a six-wheeled trailer truck. In the rigid-frame locomotives, only the comparatively slow-speed ten-coupled locomotives have two-wheeled front trucks. All of the eight- and six-coupled engines have four-wheeled front trucks. All but two have four-wheeled trailer trucks.

In grouping the locomotives, they have been separated according to the number of driving wheels, but no attempt is made to divide them into freight and passenger service No such division is practicable. The six-coupled locomotives, the Pacific, and the Hudson type are specifically designed for passenger, but a large proportion of the heavier locomotives from the eight-coupled 4-8-4 type up to the double eight-coupled articulated Mallets are designed and used for both freight and passenger service. The Norfolk and Western 2-6-6-4 engines make 65 mph with tonnage trains in regular freight service, and the Southern Pacific 4-8-8-2 locomotives with $63^1/_2$-in. drivers are reported to be capable of running 80 mph.

Attention is called to the usefulness of the 4-8-4 type for heavy-passenger or fast-freight service. With driving wheels of 75 in. diameter, this locomotive can develop a tractive effort which will fully utilize the weight on drivers and at the same time can make passenger-service speeds without unduly high rotative speeds. Present practice shows that the old idea is obsolete that a low-wheel engine was to be preferred for freight service and should be discarded. A small driving-wheel diameter has the minor advantages of less weight, particularly in the unsprung parts, and with a given stoke, a better leverage for changing piston thrust into tractive effort. These are much more than offset in a high-wheel engine by the lowered rotative speed at a given train speed in miles per hour and in the better opportunity for correct counterbalancing. Much is to be gained by making driving wheels of ample diameter for all classes of locomotives.

Returning to Table 1, it is seen that in spite of the apparent diversity, the locomotives follow a fairly definite and uniform pattern. Although designers may express their personalities in details such as trucks, the logic of the engineering requirements is inescapable. The load on a driving axle ranges up to about 75,000 lb, varying according to the road structure and the restrictions provided by the chief engineer. The number of driving axles is chosen to meet the tractive force desired, and when more than five axles are to be driven, they are split into two groups with two pairs of cylinders and an articulated frame. The general tendency is to use a four-wheeled trailing truck to provide carrying capacity for a large firebox and boiler. Exceptional boiler capacity is provided in the C.&O. locomotive by the use of a 6-wheeled trailing truck.

Driving wheels range in diameter from 57 to 70 in. in the multiaxle articulated groups, from 69 to 74 in the ten-coupled, 72 to 80 in the eight-coupled, and 79 to 84 in the six-coupled group.

To sum up Table 1 briefly, we may say that the representative steam locomotives have three, four, five, six, and eight pairs of driving wheels, ranging from the 4-6-4 type used mainly for passenger service, up to the 4-8-8-2 Mallet type used for both passenger and freight service. With a driving axle load of about 68,000 lb and a maximum tractive effort of about one quarter of this, say 17,000 lb per driving axle, the locomotives range in tractive effort from about 51,000 to 136,000 lb.

Table 1 lists four typical Diesel-electric locomotives. One freight locomotive rated at 5400 hp is composed of four units, each with two four-wheeled trucks with all axles driven. Three 4000-hp two-unit passenger or general-purpose locomotives are listed. They have two six-wheeled trucks, in each of which the center axle is idle and the outer axles are driven. One passenger locomotive has 36-in. wheels, the other three engines all have 40-in. wheels. All four locomotives have about 50,000 lb on each axle. Weight on drivers ranges from 417,000 to 461,000 lb in the passenger and up to 924,000 lb in the freight locomotives.

It will be noted that the weight on driving wheels and consequently the maximum tractive effort is high in relation to total weight if compared to that of the steam locomotives. This is accounted for by the fact that the characteristics of the Diesel engine with its practically constant speed forces the use of electric power transmission. Relatively small motors are used and are applied to a larger proportion of the total number of axles counting engine and tender than would normally be coupled if rods were used. Rapid acceleration at slow speeds is obtained, but this advantage may be more than offset by the limit to the horsepower at high speeds set by the electric motors. The steam locomotive has greater flexibility in overload capacity.

TABLE 1 REPRESENTATIVE LOCOMOTIVES

Road *Steam locomotives*	Type	Diam driving wheels, in.	Weight on drivers, lb	Service	Horsepower	Trucks per unit
U.P.	4-8-8-4	68	540,000	...	..	...
So.Pac.	4-8-8-2	$63^1/_2$	530,000	...	..	...
N.W.	2-8-8-2	57	530,000	...	..	...
C.&O.	2-6-6-6	67	470,000	...	..	...
U.P.	4-6-6-4	69	403,000	...	..	...
N.&W.	2-6-6-4	70	400,000	...	..	...
A.T.S.F.	2-10-4	74	372,000	...	..	...
C.&O.	2-10-4	69	373,000	...	..	...
A.T.S.F.	4-8-4	80	286,000	...	..	...
P.R.R.	4-8-2	72	271,000	...	..	...
D.&H.	4-8-4	75	270,000	...	..	...
N.Y.C.	4-8-2	72	266,000	...	..	...
A.T.S.F.	4-6-4	84	213,000	...	..	...
N.Y.C.	4-6-4	79	202,000	...	..	...
Diesel locomotives						
A.T.S.F.	2-unit	36	417,000	Pass.	4000	2 6-wheeled
A.T.S.F.	4-unit	40	924,000	Frt.	5400	2 4-wheeled
C.M.St.P.	2-unit	40	448,000	Pass.	4000	2 6-wheeled
N.Y.N.H. &H.	2-unit	40	461,000	Genl.	4000	2 6-wheeled

TABLE 2 RECENT LOCOMOTIVES

Road	Type	Diam of driving wheels, in.	Weight on drivers, lb
P.R.R.	4-6-4-4	77	355,000
P.R.R.	6-4-4-6	84	281,000
P.R.R.	4-4-4-4	80	268,000

Table 2 lists three novel locomotive designs put into service by the Pennsylvania Railroad recently. All are rigid-frame locomotives with two pairs of cylinders driving two groups of driving wheels. This avoids the high machine friction with four and five pairs of rod-coupled wheels and produces a free running engine. The 4-6-4-4 engine provides five pairs of driving axles for freight service. The 6-4-4-6 locomotive was exhibited at the New York World's Fair. With four pairs of driving wheels 84 in. in diameter coupled two and two and an exceptionally large boiler, it is designed to handle heavy passenger trains at high speeds. The 4-4-4-4 locomotive has also four driving axles coupled in groups of two each. It is equipped with the Franklin Steam Distribution and poppet valves and has shown high efficiency in service.

FREIGHT CARS AND PASSENGER COACHES

A survey of railroad equipment cannot omit consideration of cars. Without cars to carry the pay load, the motive power could earn nothing.

The war effort has been well served by the earlier work on car design done by the railroads. Particular mention is made of the extensive research of the Association of American Railroads, Mechanical Division, on car trucks for high-speed freight service. The information obtained as to the desirability of snubbers has been of vital importance in the revival and accelerated use of tank cars handling oil products.

The A.A.R. Committee on Car Construction has recently issued a report listing seven emergency standard designs of open-top freight cars. These designs prepared at the request of the War Production Board use wood to the greatest possible extent to save steel for war purposes. They include two 50-ton and

(Continued on page 913)

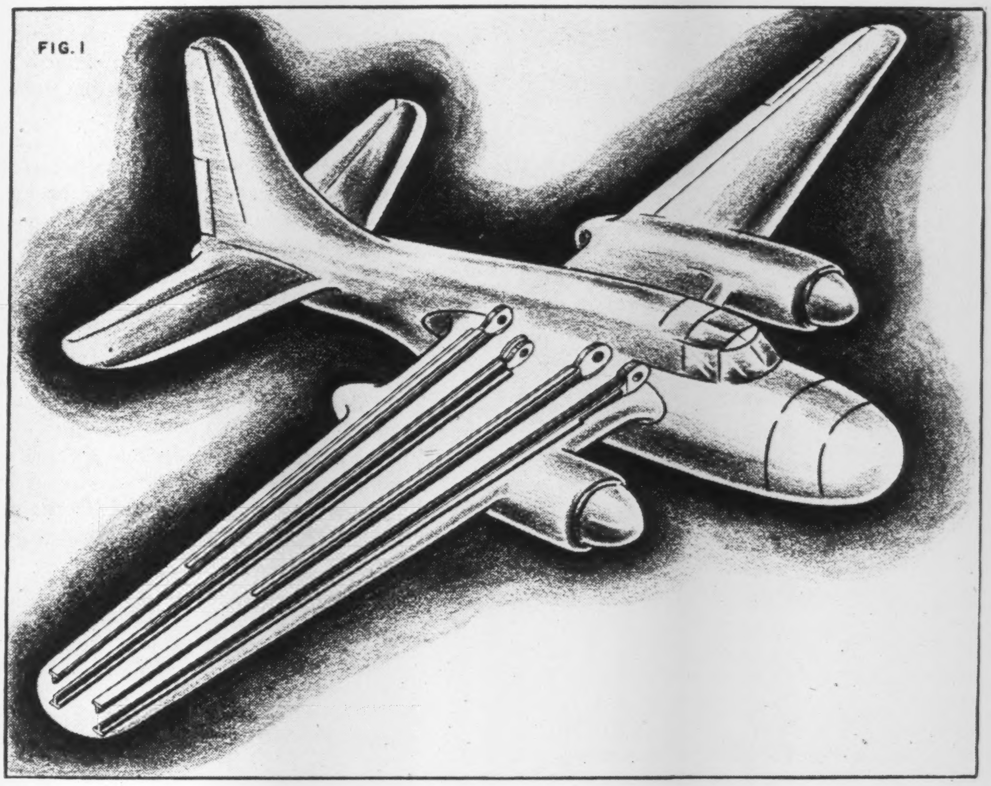

FIG. 1 LOCATION OF MAIN WING SPAR CAPS IN A CONVENTIONAL PLANE

An Introduction to HIGH-SPEED MILLING

By PAUL DUBOSCLARD

PRESIDENT, PARAGON RESEARCH, INC., ENGINEERS FOR FARNHAM MANUFACTURING COMPANY, BUFFALO, N. Y.

THERE is no telling who first discovered that aluminum alloys could be machined on woodworking tools at speeds not generally used for ferrous metals. When all-metal planes came into existence, they were built of relatively light members and, quantities being small, woodworking tools, such as routers and band saws, were adequate when the quality of the finish was not important. Critical parts such as wing attachments and landing gears, where precision machinery was required, were finished at conventional speeds on conventional metal working machine tools.

With the beginning of the second world war, it became necessary for American aircraft designers to get a new start, in order to produce better planes in larger quantities than the Axis. "Heavier-than-air" had been grounded by gravity until the internal-combustion engine had decreased the horsepower-per-pound ratio to practical limits. At the beginning of the century, airplanes just flew. During the first world war they carried about the load of a passenger automobile, at about the same speeds. At that time, the airframe designers were enough ahead of the engine manufacturers to enable the pilots to "stunt" with full engine power, in perfect safety. In the late twenties, however, larger engines became available and from then on, the airframe designers have been trying to catch up. They design a plane for the largest engine, or engines, available at the time, but soon after the plane is in production, and sometimes before, a larger engine is already being produced. That engine would overload the structure, which, consequently, has to be reinforced. In order to preserve the advantage of surplus power, such reinforcements must increase the dead weight as little as possible. By that time everything that is easy has been done and the only solution is to "throw the production engineers out," design the ideal structure regardless of precedents, send the drawings to the shops, and go on a trip without telling anybody where.

This is the situation that confronted production engineers in 1939. One of the main problems was the production of wing spar caps, Fig. 1.

These wing spar caps give extreme strength to the plane. Fig. 2 shows a 4-ft length of steel pipe firmly imbedded in the wing of a Boston bomber after its return from occupied France on a low-altitude mission. During the attack the aircraft wing struck a steel mast which sawed halfway through the main wing—through the upper and lower skin sections—and stopped only because of the strength of the spar cap itself. Except for a slight drop in flying speed the American-built bomber behaved magnificently on its trip home. This spar may have been made on a Farnham machine at Briggs Manu-

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Contributed by the Aviation Division for presentation at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of The American Society of Mechanical Engineers.

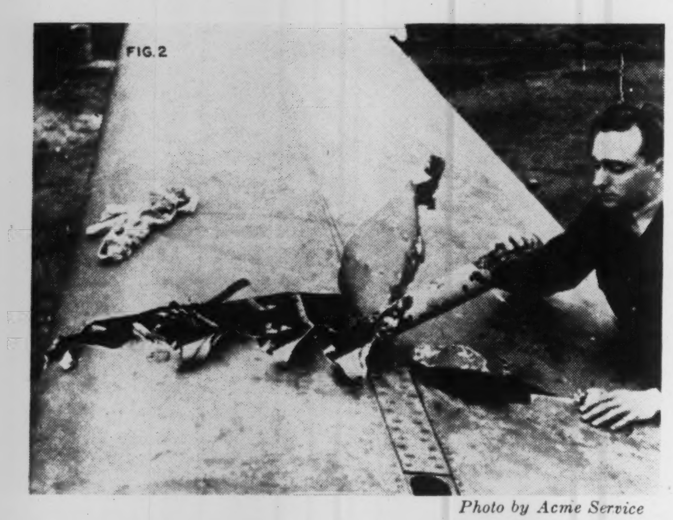

Photo by Acme Service

FIG. 2 A PLANE WING NEARLY SEVERED BY A 4-IN. PIPE MAST IN LOW-ALTITUDE FLYING

facturing Company, Detroit, where a great majority of these spars are made.

Without the strength of this spar, the wing would have been completely severed and another plane "would have failed to return."

For the reader who is not fully conversant with aircraft design, let us list the general characteristics of spar caps:

1 They are long (10 ft to 40 ft).

2 They are the primary members among all primary members.

3 They are subject to varying moments at various points (generally tapering from the fuselage to the wing tips, with a few areas of concentrated stresses; for instance, at gun emplacements, landing-gear points of attachment, or engine mounts).

4 They must be made of sound metal (either forged or extruded). That metal must be heat-treated, and heat-treatment is most reliable if the part has a constant section when heat-treated.

5 On account of ingot limitations, they must often be spliced end to end.

6 On account of manufacturing and repair requirements, they must be removable from the fuselage, and therefore, must embody some easily detachable features. (In carrier-borne aircraft, the problem is complicated by the necessity to fold and unfold wings "on the run.")

7 Last, but not least, spar caps must not weigh one ounce more than needed to carry the stresses imposed.

Out of the foregoing comes:

(*a*) A long, constant-section piece of heat-treated aluminum alloy.

(*b*) This section must be carved and profiled, in all directions, into a designer's dream, and a production man's nightmare.

In peacetime 500 to 1000 hr could be spent on one spar cap with conventional milling methods, but there are from 8 to 48 spar caps in one plane, and a wartime production of 200 planes a day would run the milling time to the astronomical figure of 240,000 hr a day, or tie up 10,000 milling machines, on three shifts, employing 30,000 operators of the highest skill. The problem came at a time when all machine-tool builders were so busy trying to keep up with the demand for standard tools that they could not possibly divert the necessary time and talent to this new research.

The Douglas Aircraft Company was, as far as we know, the first aircraft manufacturer (March, 1939) to have high-cycle super-high-speed spindles built especially to machine aluminum. These spindles were incorporated in a quickly put together machine which did some excellent work and paved the way to future development. Subsequently, Vultee Aircraft used similar setups and made further contribution to the cause.

But aircraft manufacturers had to put their best talents to better uses than machine design, and the author was asked to design and build a machine suitable for milling spars; this machine was quite successful. The following account of his experiences is based upon the performance of about 80 of these machines in operation at the present time (80 machines doing the work of 10,000 conventional mills).

THEORETICAL CONSIDERATIONS

There is no reason, at first sight, why high cutter speeds should be detrimental to cutter life (measured in number of impacts or chips produced by each tooth).

If C is the cutter and W is the work (both of identical material), and if we press (without impact) C against W with a force P, Fig. 3, sufficient to fracture the material, both the cutter and the work (being of the same material) would fracture at the same time along surfaces A_1 and A_2, and the force P necessary for fracture would be

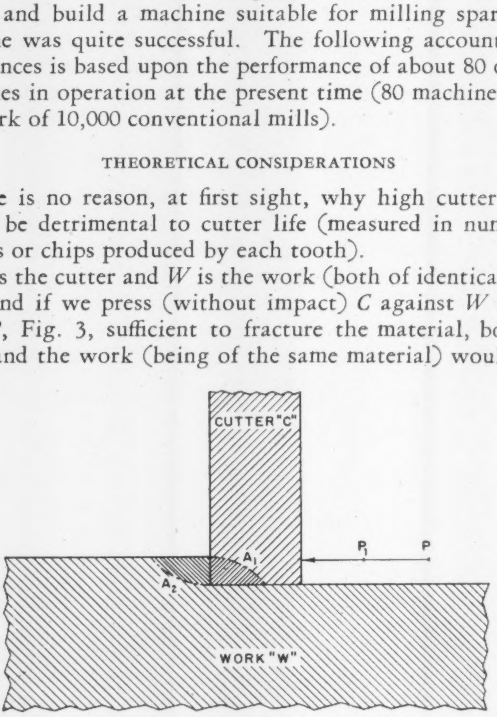

FIG. 3 ANALYSIS OF CUTTER AND WORK IN MILLING

$$P = \text{shearing strength of material} \times \text{area of } A_1 \text{ or } A.$$

Now if cutter C is in motion at a speed V, each molecule of that cutter possesses an amount of kinetic energy equal to $^1/_2\,MV^2$ when M is the mass of that molecule (measured in the same unit system as V). The kinetic energy of that cutter portion (of mass M_1) ahead of the possible fracture surface A_1 can be subtracted from the force P necessary to produce fracture at A_2, and the resultant force P_1 is not sufficient to cause fracture at A_1

$$P_1 = P - {}^1/_2\,M_1V^2$$

But the fractured portion of the work of mass M_2 is accelerated by the impact to speed V and theoretically absorbs an amount of energy equal to $^1/_2\,M_2V^2$ from the cutter. If the material in the cutter and the work is identical, $M_2 = M_1$ and we have gained nothing by speed, ***but neither have we lost anything.***

The foregoing theoretical considerations may sound like idle talk, but they point to some of the factors involved in metal cutting. These factors are as follows:

1 The area of possible fracture of the cutter A_1.

2 The area of desired fracture of the work A_2.

3 The shearing strength of the cutter material S_1.

4 The shearing strength of the work material S_2.

5 The mass M_1 of the possible cutter fragment or for fragments of equal volume; the specific gravity D_1 of cutter material.

6 The mass M_2 of the desired chip of work or for chips of equal volume; the specific gravity D_2 of the work material.

However, our discussion has not introduced the actual process of continuous-chip formation (which has been ably presented by others; for instance, by Hans Ernst and M. E.

Merchant), and we know that the coefficient of friction between the cutter and the work is actually a very important factor in cutter life (it introduces the factors of heat, cutter abrasion, speed, etc.). Everyone will realize that A_1 and A_2 are a matter of tool design and cut approach; S_1 and S_2 are self-explanatory, but the importance of D_1 and D_2, or rather the ratio D_1/D_2, may disclose why high-speed milling has, so far, been limited to materials of low specific gravity, such as wood, aluminum, and magnesium. All other factors being equal, particularly at equal shearing strength, we can expect more difficulties in attempting to cut high-specific-gravity materials such as ferrous alloys.

A complete technical discussion of all the factors involved in taking a cut of depth T and width B in a certain material with a certain cutter at a certain speed and a certain chip load would have to consider, in addition to those variables, the elastic deformation of the work and its supports, the elastic deformation of the cutter tooth and its complex supports, a few unknown coefficients of friction, etc. Such a discussion would fill a volume and have little practical value because a slight change of one variable would necessitate a new study. When the war is over, we may have time to undertake such a discussion, but at present, we shall have to give empirical results and merely point to the fundamental principles which would act as a basis for a technical study.

DESCRIPTION OF SPAR-MILLING MACHINE

As we describe the various elements of the machine, we shall note in parentheses the fundamental reason for choosing a particular type of construction.

Bed. Fig. 4 gives a diagrammatic sketch of the mill; it is illustrated further by reproductions of photographs, Figs. 5 to 9.

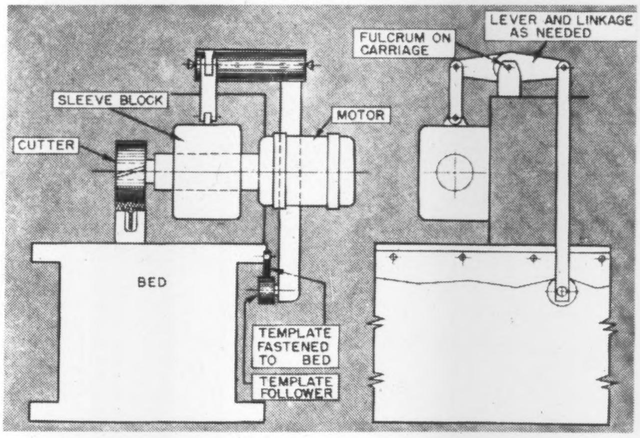

FIG. 4 DIAGRAM OF SPAR MILL

The bed is made of steel (rigidity) of complete box-type construction (rigidity) welded (flexibility of design) and stress-relieved (shape permanency) (Fig. 5). This bed carries the V-flat way (Fig. 6) on which rides the milling carriage, and the template holders (Fig. 7) in inverted position on the side of the machine to avoid chip contamination. It also supports the work and forms the stationary element (principle of inertia, second part) of the cutters. The work is held on the bed through the intermediary of a workholder of massive construction (Fig. 8) (inertia). Because the milling time at high speed is reduced to a few minutes, the idle time when clamping or unclamping the work (20 ft long, average) would be relatively large. Therefore hydraulic clamping means are provided in the workholder (air clamping means proved to be "bouncy"). Note that the clamping time and setup time are not any less important on a slow machine than on a fast machine, but they do not stare anybody in the face and, therefore little is done about them. Between the top of the workholder and the work, pads of nonresonant material (Douglas Aircraft has introduced Kirksite pads with much success) are generally provided; these pads are readily changed when changing setups and can be machined in the machine itself at high speed (a very desirable feature when the fixture is, say, 60 ft long). Fig. 9 shows the clamps and workholder assembled in the Farnham spar-milling machine.

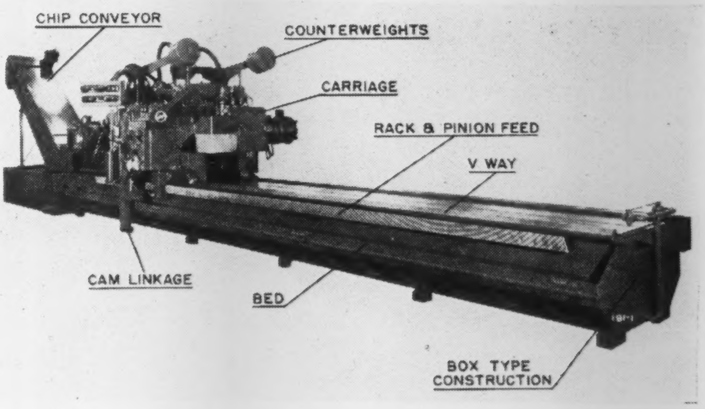

FIG. 5 FARNHAM SPAR MILL, SHOWING BED

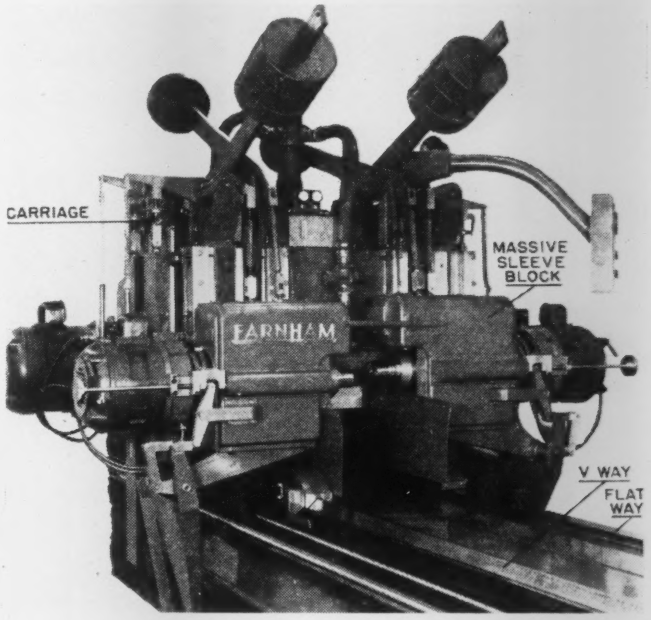

FIG. 6 FARNHAM SPAR MILL, SHOWING SUPPORT OF CARRIAGE ON V- AND FLAT WAYS

Carriage. The carriage, Fig. 10, is of steel, welded, stress-relieved, box construction, and slides along the bed on self-aligning lead-bronze shoes. The carriage is propelled lengthwise, either by a screw or helical rack and pinion, at variable speeds (generally between 24 and 240 ipm). The carriage supports as many milling heads as it is desired to operate at one time (however, it is not generally desirable to assemble more than four heads on one carriage). As many carriages as needed can be provided on the same bed; some of these carriages can be limited to local operations while others carry full-length operations.

Each milling head is mounted in the carriage (singly or in group) and connected through the simplest mechanical linkage (Fig. 11), to a cam follower which rolls along a suitable template. This linkage imparts to the head whatever motion is

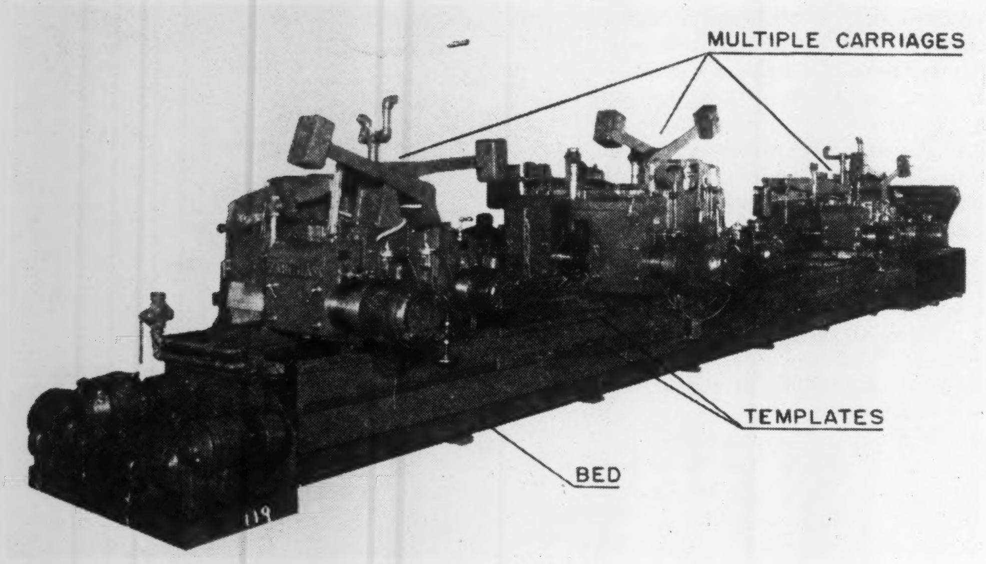

FIG. 7 FARNHAM SPAR MILL, SHOWING TEMPLATES ON SIDE OF MACHINE

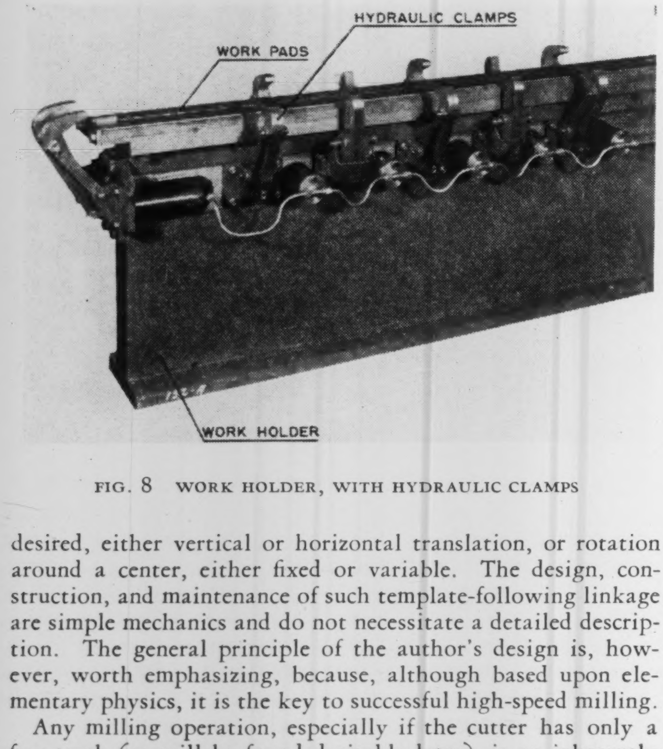

FIG. 8 WORK HOLDER, WITH HYDRAULIC CLAMPS

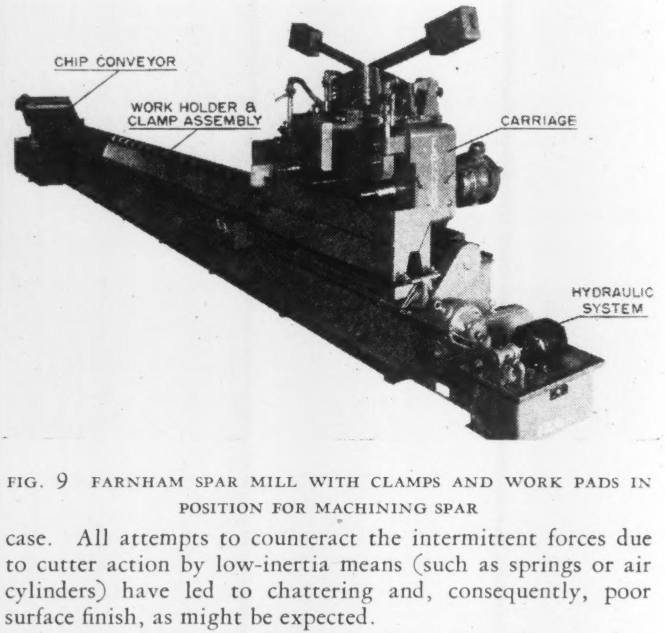

FIG. 9 FARNHAM SPAR MILL WITH CLAMPS AND WORK PADS IN POSITION FOR MACHINING SPAR

desired, either vertical or horizontal translation, or rotation around a center, either fixed or variable. The design, construction, and maintenance of such template-following linkage are simple mechanics and do not necessitate a detailed description. The general principle of the author's design is, however, worth emphasizing, because, although based upon elementary physics, it is the key to successful high-speed milling.

Any milling operation, especially if the cutter has only a few teeth (as will be found desirable later), is an inherently intermittent or pulsating operation. Each tooth entering the work creates an impact, followed by variable reactions, then by a lull while no tooth is in the work. These forces have the general tendency to divert the cutter away from the desired line of action (the work itself is fastened on the bed and subject only to elastic deformation, we hope). Because, with a cutter revolving at high speed, these forces vary from zero to their maximum and back to zero in a small fraction of a second, the easiest way to dispose of these reactions is to make them lift the weight of the milling head. Anyone conversant with acceleration forces can figure out that a free 2000-lb weight subject to a lifting force of 3000 lb for 0.001 sec will be lifted only 0.0001 in. in that period of time. In other words, the author is taking advantage of the fact that mass resists any quick changes of accelerating forces but submits relatively easily to slow-acting forces, such as template action in this case. All attempts to counteract the intermittent forces due to cutter action by low-inertia means (such as springs or air cylinders) have led to chattering and, consequently, poor surface finish, as might be expected.

In view of the foregoing principle, each milling head is made as massive as possible and is closely fitted into a bored cast-iron block of great mass. This, so-called "sleeve block" is the one that is attached to the template following linkage. The sleeve block is counterbalanced by cast-iron counterweights which also add to the inertia of the system.

The result is that the cutter "floats" over the work a few thousandths over the position that it would occupy at rest. This "float" is somewhat proportional to the cutting effort, for instance, it is greater in a "plunge cut" than in a rising cut. Small corrections have to be made on the templates to compensate for the amount of float. Differences in cutter sharpness generally do not affect the float sufficiently to throw the cut out of tolerance.

Milling Heads. The design of the milling heads, running at a basic speed of 3600 rpm, would deserve a lengthy description which is outside of the scope of this paper. Let us just mention that they are equipped with superprecision, spring-loaded ball bearings, that the motor rotor is directly mounted on the spindle, and that oil-vapor lubrication under positive air pressure is provided.

OPERATING RESULTS; HORSEPOWER

The first machine built, March, 1940, had two 10-hp milling heads; the second machine had two 15-hp milling heads; on subsequent machines the power was gradually stepped up to 20, 30, 40 hp per head without any trouble, regardless of the fact that these motors have been overloaded to the stalling point. Not having as yet encountered any limiting factor, the author could not venture an opinion as to what the maximum horsepower per head could be.

Most of the heat generated by cutting goes with the chip (the part that goes into the work goes out with the next chip) and the result has been that 200 hp cutting the same spar at the same time raises the temperature of the spar less than 15 F. Therefore no limitation is in sight in that direction either, because cooler coolant could be used.

The amount of aluminum alloy (24S-T) removed per horsepower per minute varies with the sharpness of the cutter and the horsepower behind it; the larger the horsepower the larger the amount of metal removal per horsepower. This is due to the fact that the idling-power losses of a large motor are not much greater than those of a small motor; also larger motors will permit a heavier chip load which is more efficient than a small chip load. Consequently, results vary from 2.5 to 4 cu in. of metal removed per hp per min (14S-T aluminum alloy takes a trifle less power than 24S-T). The rigidity of the clamping of the work seems most important because all high-production figures have been obtained with rigid clamping.

Spindle Speeds. The peripheral speed of the cutter is a function of spindle speed and cutter diameter. No upper limit to peripheral speed has been found, and results are still good at speeds as low as 3000 fpm. Therefore, single-speed spindles are satisfactory, and cutters should be made as large as possible, within physical limitations; 9-in-diam cutters are very satisfactory, although it is difficult to tell the difference between their performance and that of an 8-in. cutter.

The author advocates the use of large cutters rather than super-high spindle speeds (over 3600 rpm) for the following reasons:

(*a*) Super-high spindle speeds call for high-cycle current which, although far more common than a few years ago, must still be generated by the user in quantity large enough to take care of peak loads. It is an investment and a complication, to say the least.

(*b*) Spindles should be made as massive as possible to stand all the abuses of production and avoid the necessity of an outboard bearing. Such large-diameter spindles necessitate fairly large bearings which at super-high speeds give plenty of trouble; they heat up if adjusted tightly or chatter if loosely adjusted. The perfect adjustment is a matter of temperature balance, but it is difficult to maintain.

(*c*) Large cutters can be made massive and, on account of their large WR^2, will absorb a large part of the tooth-impact load right at the source (principle of inertia). (Note that the addition of a flywheel to the cutter always leads to better finish, Fig. 12.)

(*d*) Large cutters (with two or four teeth), with inserted teeth, are easier to build than small cutters. The mass of the body being either boiler plate or cast iron is very inexpensive. No alloy steel is needed. These cutters, being bolted to the face of the spindle, are more easily and safely secured than taper-stem cutters fastened with a drawbolt.

(*e*) In many cases, straddle cuts are necessary, and therefore large cutters must be used for physical reasons.

Feed Speeds. Feed speeds are determined by the available horsepower, and the cross section of the cut. There is, however, a low limit which is determined by the chip load and

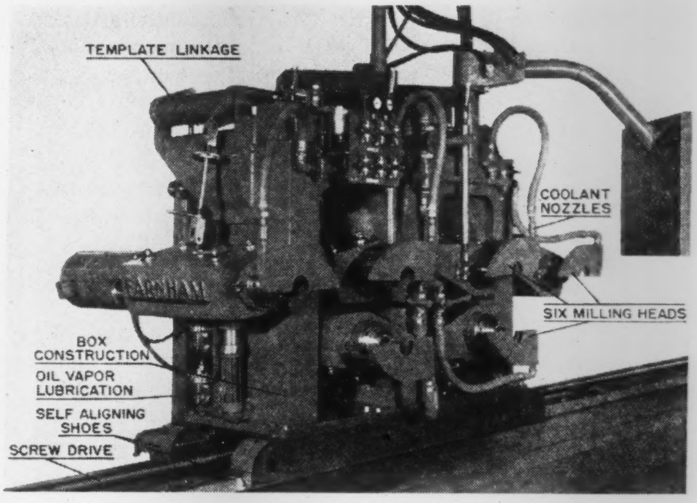
TEMPLATE LINKAGE
COOLANT NOZZLES
SIX MILLING HEADS
BOX CONSTRUCTION
OIL VAPOR LUBRICATION
SELF ALIGNING SHOES
SCREW DRIVE
FARNHAM

FIG. 10 CARRIAGE OF FARNHAM SPAR MILL, SHOWING SIX MILLING HEADS

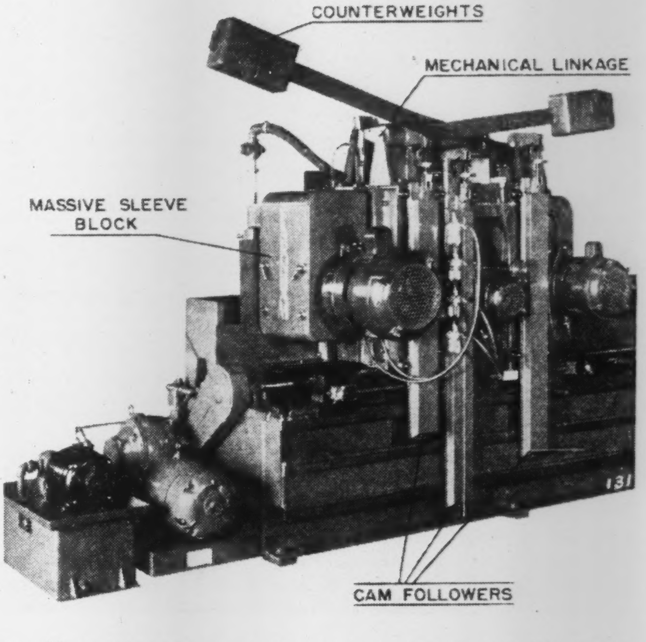
COUNTERWEIGHTS
MECHANICAL LINKAGE
MASSIVE SLEEVE BLOCK
131
CAM FOLLOWERS

FIG. 11 CARRIAGE, SHOWING MOTOR ENDS OF MILLING HEADS

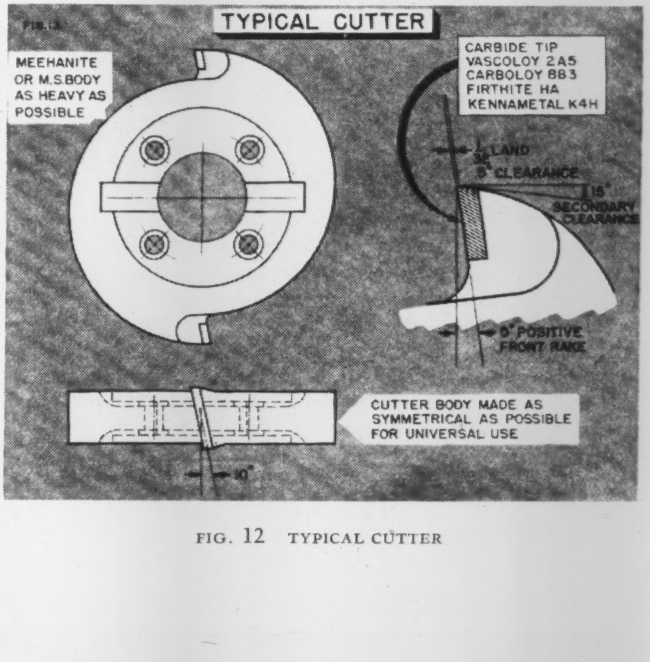
FIG. 12
TYPICAL CUTTER
MEEHANITE OR M.S.BODY AS HEAVY AS POSSIBLE
CARBIDE TIP
VASCOLOY 2A5
CARBOLOY 883
FIRTHITE HA
KENNAMETAL K4H
1/32 LAND
5° CLEARANCE
15° SECONDARY CLEARANCE
0° POSITIVE FRONT RAKE
CUTTER BODY MADE AS SYMMETRICAL AS POSSIBLE FOR UNIVERSAL USE
10°

FIG. 12 TYPICAL CUTTER

the number of teeth in the cutter. The minimum chip load (for fair cutter life) is about 0.003 in., and the minimum number of teeth is, of course, one. Obviously we have

$$\text{Area of cut} \times \text{length of cut per min} = \text{Material removed per min}$$

or

$$= \text{Material removed per hp per min} \times \text{hp}$$

$$\frac{\text{Hp} \times \text{material removed per hp per min}}{\text{Area of cut}} = \text{Length of cut per min, or feed} \ldots\ldots\ldots [1]$$

For instance, a cut of 1.5 sq in. to be removed with a 20-hp spindle (assuming 3 cu in. per hp per min) would call for a feed speed of

$$\frac{20\,(\text{hp}) \times 3}{1.5} = 40 \text{ ipm}$$

At 40 ipm, a 4-tooth cutter would take

$$\frac{40\,(\text{in.})}{4\,(\text{teeth}) \times 3600\,(\text{rpm})} = \frac{1}{360} = 0.028 \text{ in.}$$

That tooth load is rather small, and a cutter with two teeth only would be far more satisfactory.

But if a cut of 6 sq in. had to be removed, the feed would have to be dropped to 10 ipm, which, with even a single-bladed cutter, would produce an unsatisfactory chip load. Two passes, each removing 3 sq in., with a single-bladed cutter, would be the answer.

Anyone working a few examples with Equation [1], will see that cutters with more than four teeth will seldom be required, except for very light cuts at a high feed rate. We cannot overemphasize the fact that a cutter with even one more tooth than necessary is not an efficient cutter.

Coolant. The influence of coolants, such as soluble oils (CCl_4 has not been tried in spar-milling), has not been conclusively ascertained. Their value as a lubricant seems to be very doubtful, except for the quenching action of the water which might reduce chip friction. Their value as a coolant for the work, the chips, and the cutters may not be as important as believed at first, although they seem to reduce the warpage of the finished products. (Parts finished by high-speed, high-capacity milling show very little warpage, but the reason may be that the chips carry the heat away, if they are produced fast enough.) The value of a large amount of liquid as a chip conveyer cannot be underestimated, however, not when one machine may produce 15 cu ft of chips per min. Therefore one can just as well play the liquid on the cutter and use whatever advantage there is in the cooling action.

VERTICAL SPINDLE VERSUS HORIZONTAL SPINDLE (FIG. 13)

Since the quality of the finish depends upon the combined inertia of the workpiece and its supports in the direction of the cutting-force resultant, it follows that the main cutting action should be at right angles to the bed of the machine, or that the axis of the cutter should be in a plane parallel to the bed surface. Because it is generally easier to set up the workpiece on a horizontal surface, machine beds are horizontal, and therefore horizontal spindles, using slab cutters, should give the best results. Experience has confirmed this theoretical conclusion and vertical milling (spindle perpendicular to the machine bed) should be avoided as much as possible. There are, of course, some auxiliary operations which are best done with a vertical head but in that case a small rate of metal removal and a poor finish will be the penalty (Fig. 14). In most cases, the engineering department can "design out" such nasty operations.

HIGH-SPEED MILLING OF FERROUS ALLOYS

When a green operator accidentally ran into a steel clamp with an 8-in. carbide cutter running at 3000 rpm with a feed of 50 ipm and cut the clamp neatly without injuring the cutter, he gave a jolt to everyone interested in metal cutting and opened a new field of research. Unfortunately, conventional milling machines have not the power, the massive construction, and the range of speed necessary for such tests. Consequently, all experiments had to be conducted, "on borrowed time," on Farnham spar millers. These machines seem to have "all that it takes" to test high-speed milling of ferrous metals, but they are all in use for war production and cannot be diverted for a lengthy research. Through the courtesy of the Douglas Aircraft Company, one of their Farnham spar millers was made available during a 2-day lull due to retooling, and 15 test runs were made on various steels, at various speeds with various cutters. Time was too short to carry out a systematic program of research and, consequently, the results were far from conclusive. However, they showed the following:

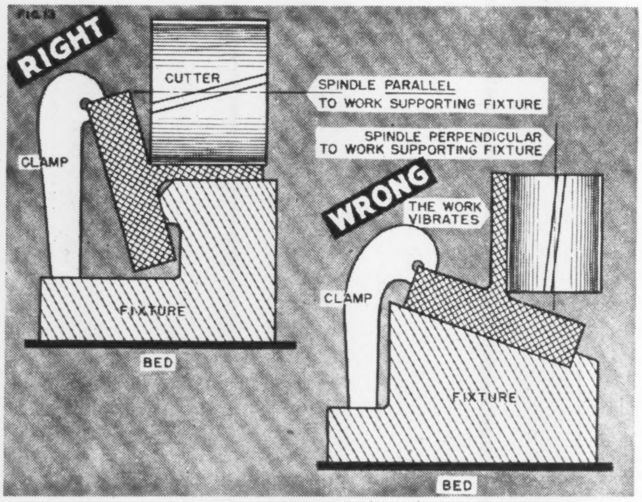
FIG. 13
RIGHT
CUTTER
SPINDLE PARALLEL TO WORK SUPPORTING FIXTURE
SPINDLE PERPENDICULAR TO WORK SUPPORTING FIXTURE
CLAMP
WRONG
THE WORK VIBRATES
FIXTURE
BED
CLAMP
FIXTURE
BED

FIG. 13 HORIZONTAL VERSUS VERTICAL MILLING

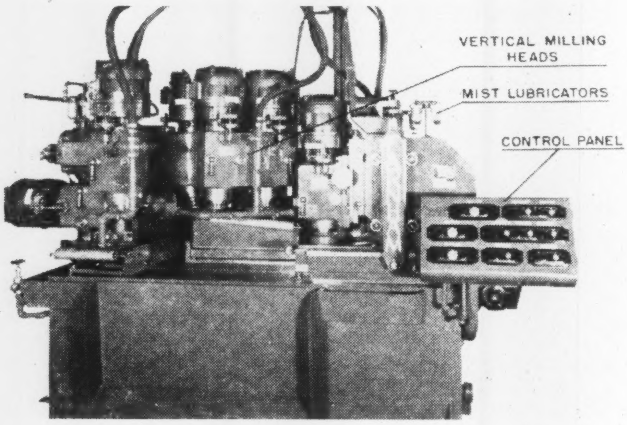

FIG. 14 VERTICAL-HEAD MILLING MACHINE

1 That cutter abrasion was the cause of failure (carbide cutters only were tested, various grades of various brands).

2 That high chip loading was beneficial (best results with two-bladed cutter; 120 ipm feed).

3 That a high rate of metal removal could be expected (over 2.5 cu in. per hp per min).

4 That what we know is still a very small drop in the bucket of what we do not know, and that cutting metal is still very much of an art and very little of a science.

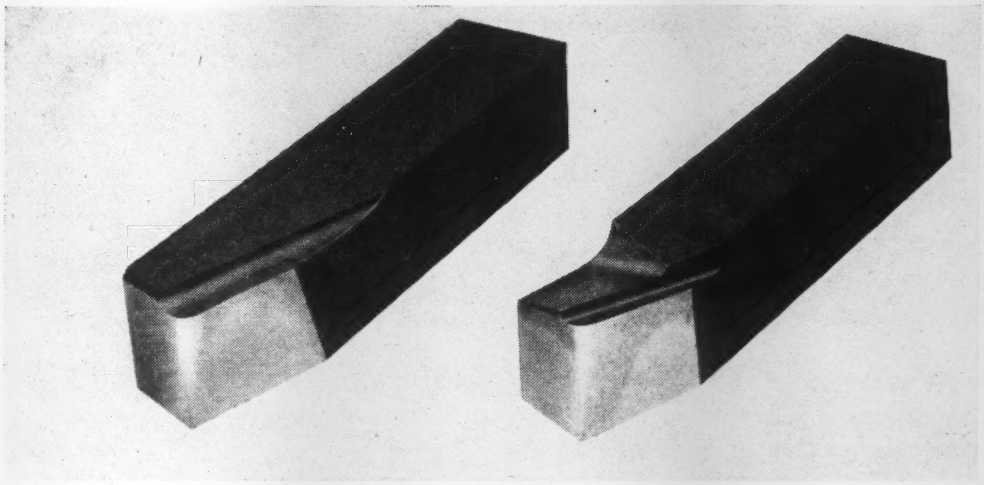

FIG. 1 PARALLEL AND NONPARALLEL TYPES OF CHIP BREAKER

Parallel chip breaker		Nonparallel chip breaker
15 deg	Side-cutting edge angle	15 deg
26 deg	End-cutting edge angle	26 deg
6 deg	Side-clearance angle	6 deg
6 deg	End-clearance angle	6 deg
13 deg	Side rake on chip breaker	13 deg
0 deg	Back rake on chip breaker	5 deg
15 deg	Side-shoulder angle	21 deg
..	Top-face back rake	5 deg
	Top-face side rake	13 deg
$^{1}/_{16}$ in.	Nose radius	$^{1}/_{16}$ in.
$^{1}/_{4}$ in.	Width of chip breaker	$^{3}/_{16}$ in.
$^{3}/_{64}$ in.	Depth of chip breaker	$^{3}/_{16}$ in.
$^{1}/_{8}$ in.	Radius of chip breaker	$^{3}/_{64}$ in.

Standardization of CUTTING TOOLS

Development of Fine-Finished, Single-Point, Chip-Breaker Type

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THE standardization of single-point high-speed-steel (H.S.S.) cutting tools has been the outcome of tests conducted over a period of 18 months in the shops of the Wright Aeronautical Corporation. As the investigation developed, the realization grew that the present complicated and expensive automatic machine tools will not pay dividends if the single-point tools used in the tool setup are improperly designed and applied.

The research showed that the H.S.S. cutting-tool life could be extended in some cases as much as 2000 per cent by the combination of correct design, by proper tool setups, and by fine-tool finish.

The preliminary investigation in the shop revealed that a large variety of hand-ground tools gave only a limited tool-life performance. A period of development followed in which were produced fine-finished tools of improved design, including a step-type chip breaker.

TESTING VARIOUS TYPES OF CHIP BREAKERS

The original design selected included a nonparallel chip breaker with 5-deg back rake, which is illustrated in Fig. 1. Surface speed, feed, depth of cut, and type of material being cut are factors to be considered in designing the proper width and angle of chip breaker, and the design mentioned was selected as giving the best results on the majority of rough-turning operations on aircraft forgings. The step-type chip breaker was selected because shop tests proved that the use of tools without chip breakers or with groove-type chip breakers resulted in unsatisfactory chip formation and tool life.

Use of this type of tool indicated that slight changes would make it a better all-purpose tool. Another investigation was therefore conducted to establish a revised design. Ten different tools were tested and the design finally selected for general use incorporated a parallel chip breaker with no back rake which is also illustrated in Fig. 1. The selection was made on the basis of tool-life, surface finish, power consumption, chip formation, simplified grinding, and design. The results of these tests are given in Tables 1 and 2 and are illustrated in Figs. 2(*a*, *b*, *c*, *d*, *e*, *f*, *g*). These illustrations show the effect of tool design on the machining of S.A.E. 3312 and modified Nitralloy G steels using soluble-oil emulsion (WAC 61) and sulphurized cutting oil (WAC 3AB). The emulsion consisted of water and soluble oil 12 to 1. The cutting oil consisted of one part sulphurized fatty-oil base and five parts of 100 second paraffin oil.

Additional tests made to determine the effect of fine finish and chip-breaker design revealed that tools without chip breakers produced unmanageable chips and showed excessive cratering. The fine-finish (4–8 microfinish) tool was found to increase tool life approximately 85 per cent over that of tools with ordinary finish (60–80 microfinish) of identical design.

So conclusive were the results of these extensive tests it was

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Contributed by Special Research Committee on Cutting of Metals for presentation at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

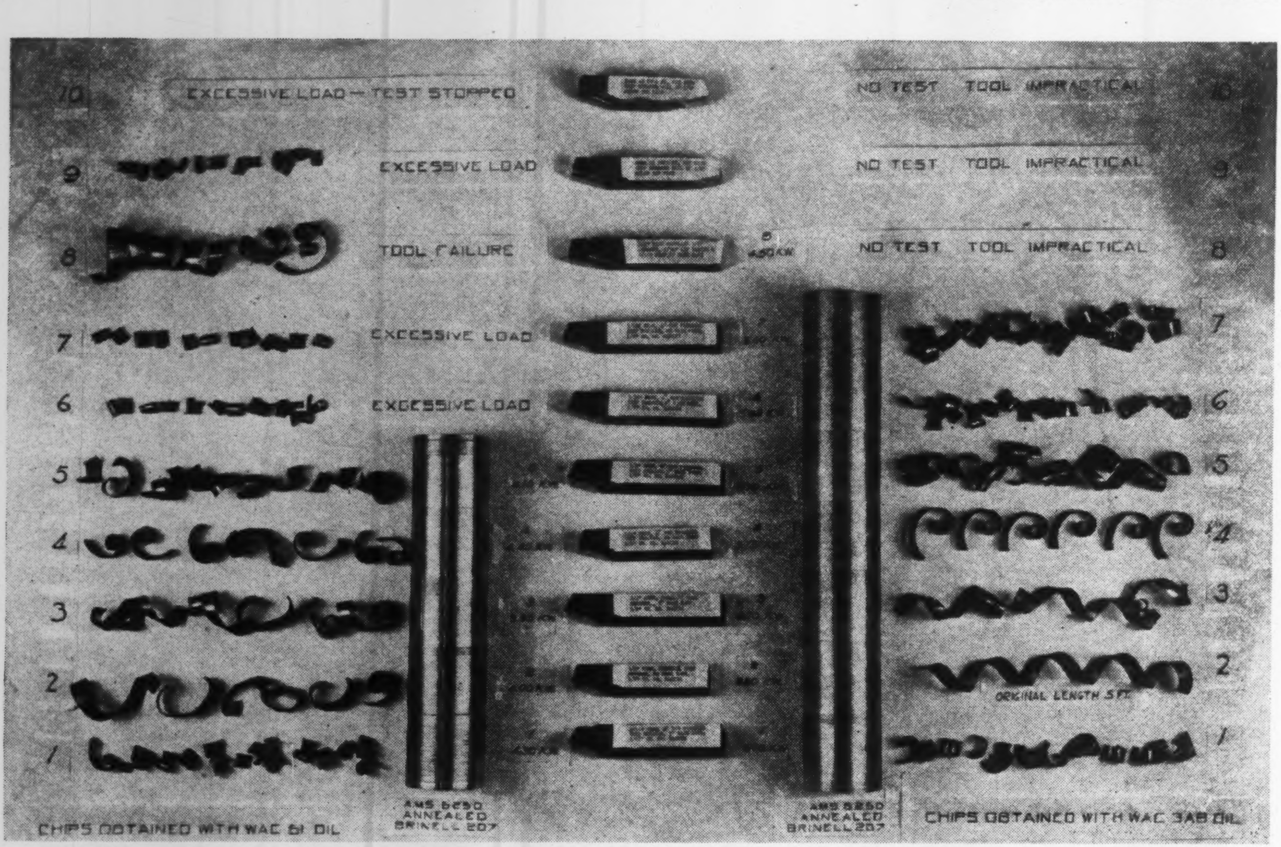

10
EXCESSIVE LOAD — TEST STOPPED
NO TEST TOOL IMPRACTICAL
10
9
EXCESSIVE LOAD
NO TEST TOOL IMPRACTICAL
9
8
TOOL FAILURE
NO TEST TOOL IMPRACTICAL
8
7
EXCESSIVE LOAD
7
6
EXCESSIVE LOAD
6
5
5
4
4
3
3
2
2
ORIGINAL LENGTH 5 FT.
1
1
CHIPS OBTAINED WITH WAC 51 OIL
AMS 6250
ANNEALED
BRINELL 207
AMS 6250
ANNEALED
BRINELL 207
CHIPS OBTAINED WITH WAC 3AB OIL

FIG. 2(*a*)

(Tool test: Tools of different design were run under identical conditions. Surface speed, 105 ft per min; feed, 0.015 in. per rev.; depth of cut, $^3/_8$ in.; length of cut, 2 in.)

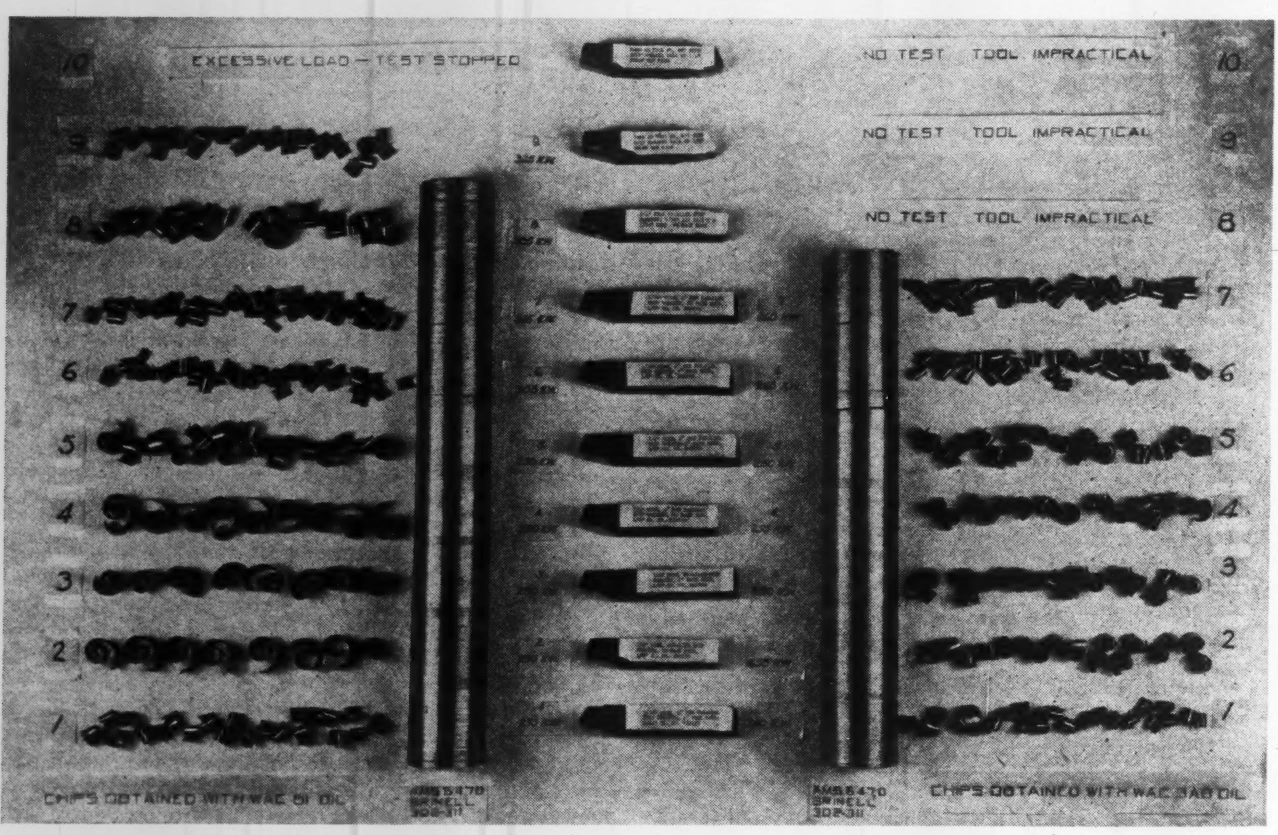

10
EXCESSIVE LOAD — TEST STOPPED
NO TEST TOOL IMPRACTICAL
10
9
NO TEST TOOL IMPRACTICAL
9
8
NO TEST TOOL IMPRACTICAL
8
7
7
6
6
5
5
4
4
3
3
2
2
1
1
CHIPS OBTAINED WITH WAC 51 OIL
AMS 6470
BRINELL
302-311
AMS 6470
BRINELL
302-311
CHIPS OBTAINED WITH WAC 3AB OIL

FIG. 2(*b*)

(Tool test: Tools of different design were run under identical conditions. Surface speed, 60 ft per min; feed, 0.015 in. per rev.; depth of cut, $^3/_8$ in.; length of cut, 2 in.)

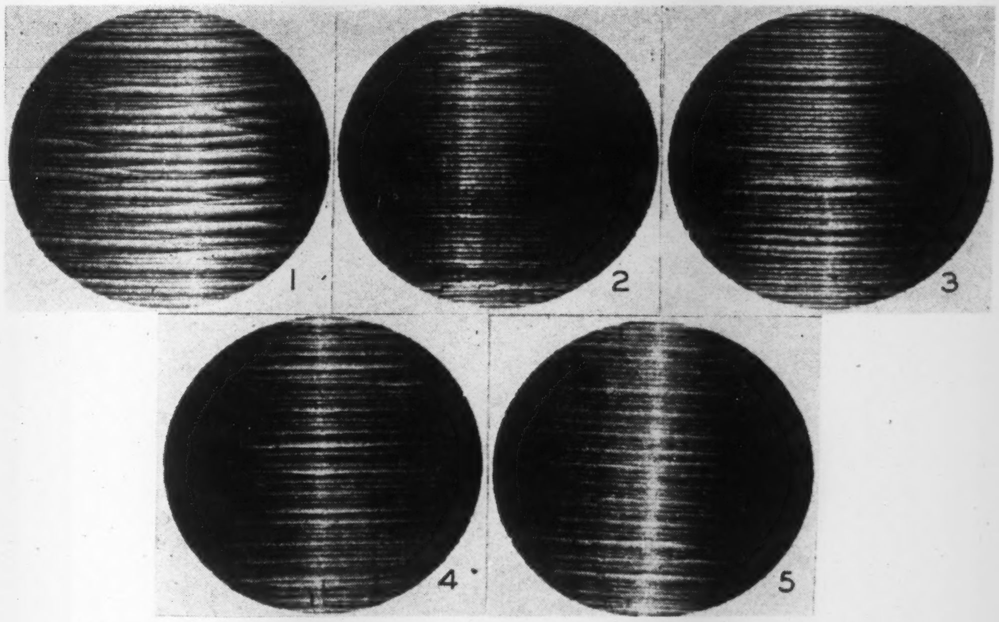


FIG. 2(*c*)

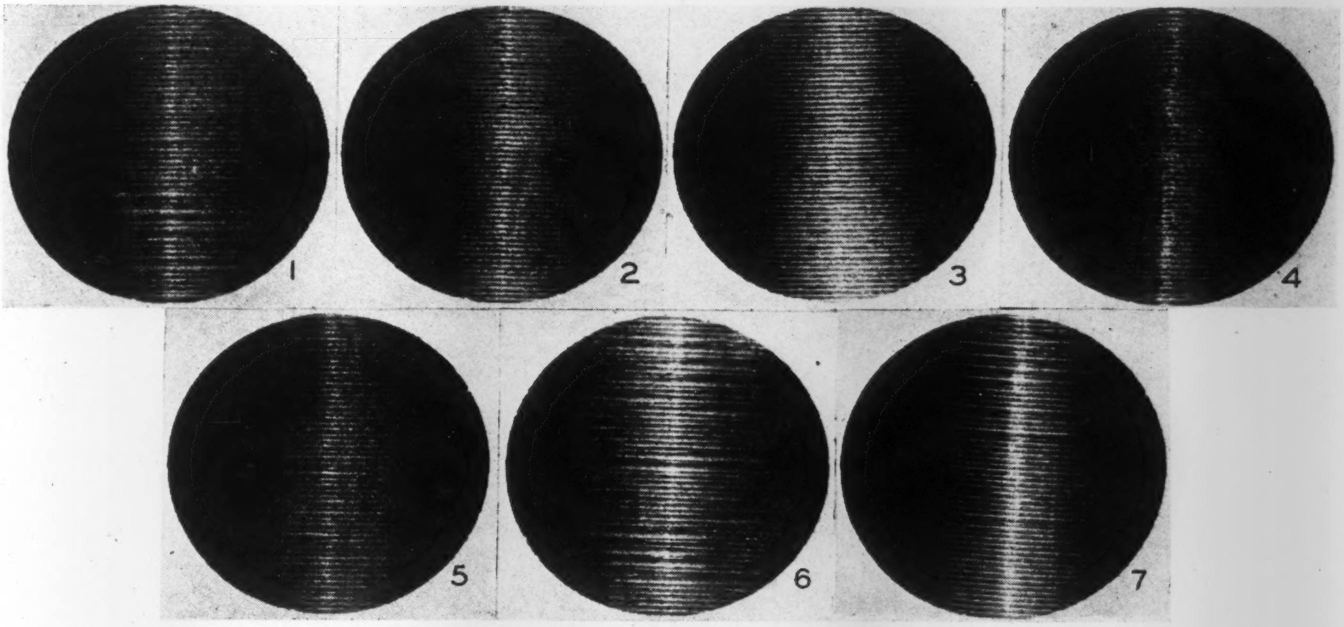


FIG. 2(*d*)

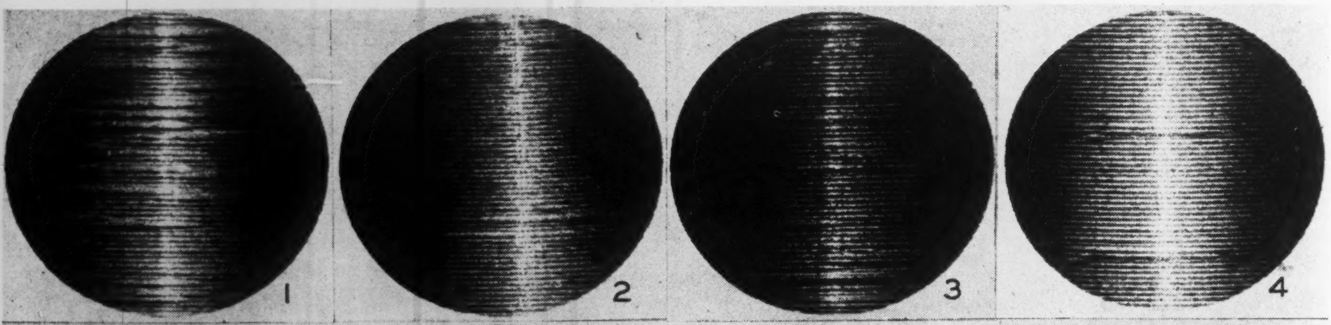
quite evident that the standardization of this type of tool would effect a considerable saving in the cost of the finished product. In connection with the standardization, it was also realized that production grinding would be required on a precision tool of this design in order to obtain the desired efficiency and economy of the complete setup.

STANDARDIZATION OF HIGH-SPEED-STEEL TOOLS

The original plan for the standardization was to apply the features of the fine-finished parallel-type chip breaker to current tools but the preliminary investigation indicated that such a plan would involve an enormous number of different tools, thus upsetting the program. The problem was therefore tackled from a different viewpoint and the current tools were disregarded. The final standardization includes four classes of tools, namely, turning, facing, boring, and chamfering. The standards are set up in book form and include instructions for selection of the tool, tool-position sketches, and tool-selection tables.

In standardizing, the number of tool-shank sizes was held to a minimum, i.e., seven for turning and facing, six for boring, and five for chamfering. The nose radii were limited to seven values between 0.030 to 0.250 in. The tool-holder-slot angles selected vary between 0 and 90 deg in intervals of 5 deg. This rather large selection of slot angles was necessary in order to provide tools for the existing tool blocks, but it is believed that in the case of new equipment the number of slot angles can be reduced considerably.

Each tool has been assigned a "T" number and style number. A blueprint has been prepared for each "T" number, applicable to solid or tipped tools incorporating the step-type chip breaker and fine finish (4–8 μ in.). A style number is assigned to each tool in the standards, which is derived from the two main cutting angles and is not in any way related to the size of the tool.



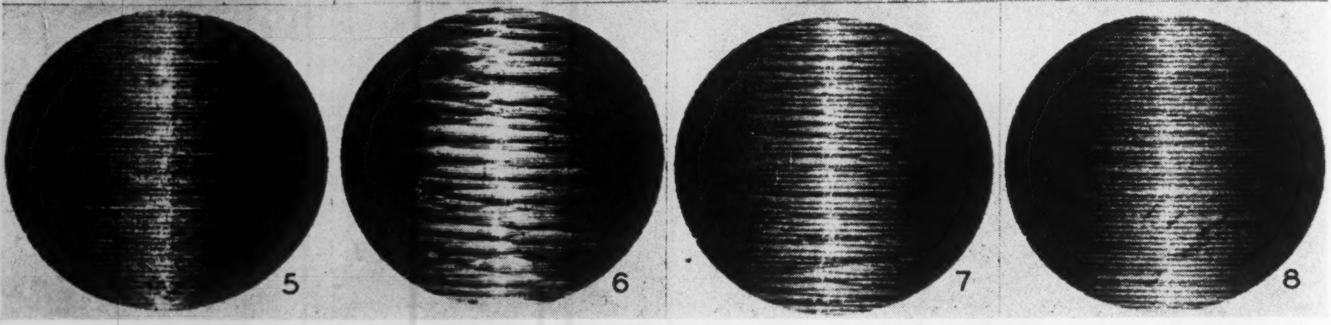


FIG. 2(*e*) TOP ROW

FIG. 2(*g*) BOTTOM ROW

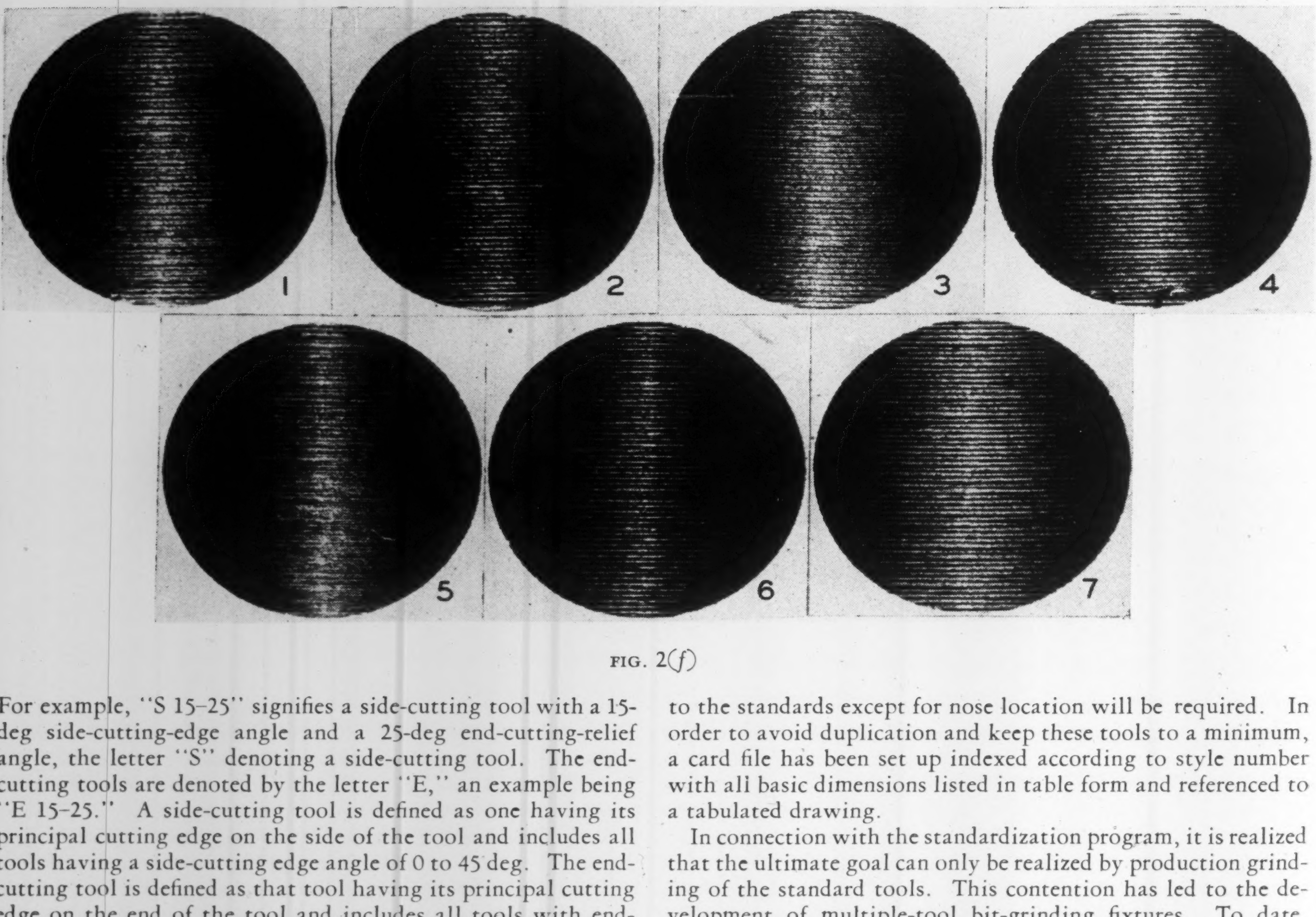


FIG. 2(*f*)

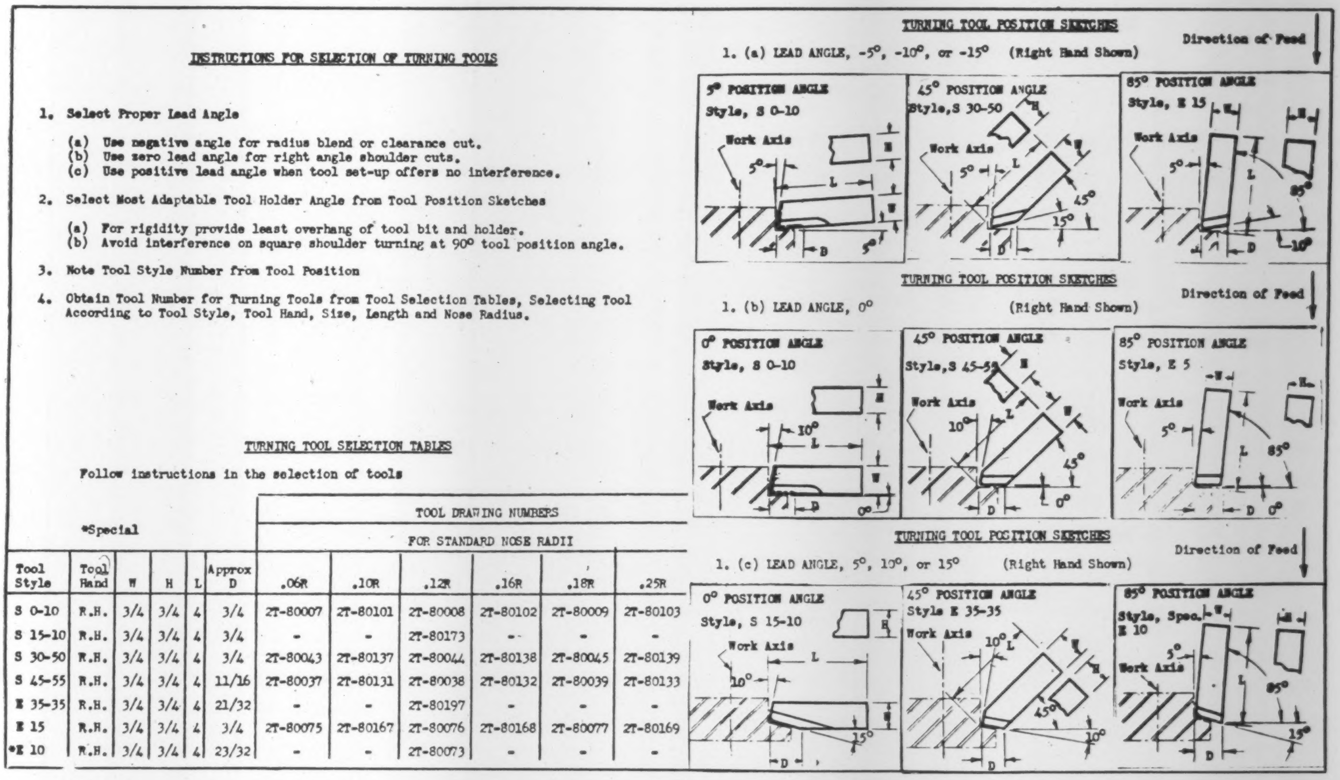
For example, "S 15–25" signifies a side-cutting tool with a 15-deg side-cutting-edge angle and a 25-deg end-cutting-relief angle, the letter "S" denoting a side-cutting tool. The end-cutting tools are denoted by the letter "E," an example being "E 15–25." A side-cutting tool is defined as one having its principal cutting edge on the side of the tool and includes all tools having a side-cutting edge angle of 0 to 45 deg. The end-cutting tool is defined as that tool having its principal cutting edge on the end of the tool and includes all tools with end-cutting-edge angles of 0 to 45 deg.

Figs. 3 to 6, inclusive, are excerpts from standards relating to turning tools, facing tools, boring tools, and chamfering tools, respectively. Fig. 7 is an example of tool drawing.

In conjunction with the standardization program we have found that form tools and some special tools which are identical to the standards except for nose location will be required. In order to avoid duplication and keep these tools to a minimum, a card file has been set up indexed according to style number with all basic dimensions listed in table form and referenced to a tabulated drawing.

In connection with the standardization program, it is realized that the ultimate goal can only be realized by production grinding of the standard tools. This contention has led to the development of multiple-tool bit-grinding fixtures. To date, the multiple grinding fixtures have not been placed in service and until such time as these are ready for use, the following procedure is applied in grinding these tools:

Fig. 8 shows rough-grinding side and end faces on a Sellers tub grinder, using a soft coarse-grained vitrified-bond aluminum-oxide wheel (carborundum No. 30-0-200).



INSTRUCTIONS FOR SELECTION OF TURNING TOOLS

1. Select Proper Lead Angle
   - (a) Use negative angle for radius blend or clearance cut.
   - (b) Use zero lead angle for right angle shoulder cuts.
   - (c) Use positive lead angle when tool set-up offers no interference.
2. Select Most Adaptable Tool Holder Angle from Tool Position Sketches
   - (a) For rigidity provide least overhang of tool bit and holder.
   - (b) Avoid interference on square shoulder turning at 90° tool position angle.
3. Note Tool Style Number from Tool Position
4. Obtain Tool Number for Turning Tools from Tool Selection Tables, Selecting Tool According to Tool Style, Tool Hand, Size, Length and Nose Radius.

TURNING TOOL SELECTION TABLES

Follow instructions in the selection of tools

*Special

						TOOL DRAWING NUMBERS					
						FOR STANDARD NOSE RADII					
Tool Style	Tool Hand	W	H	L	Approx D	.06R	.10R	.12R	.16R	.18R	.25R
S 0-10	R.H.	3/4	3/4	4	3/4	2T-80007	2T-80101	2T-80008	2T-80102	2T-80009	2T-80103
S 15-10	R.H.	3/4	3/4	4	3/4	-	-	2T-80173	-	-	-
S 30-50	R.H.	3/4	3/4	4	3/4	2T-80043	2T-80137	2T-80044	2T-80138	2T-80045	2T-80139
S 45-55	R.H.	3/4	3/4	4	11/16	2T-80037	2T-80131	2T-80038	2T-80132	2T-80039	2T-80133
E 35-35	R.H.	3/4	3/4	4	21/32	-	-	2T-80197	-	-	-
E 15	R.H.	3/4	3/4	4	3/4	2T-80075	2T-80167	2T-80076	2T-80168	2T-80077	2T-80169
*E 10	R.H.	3/4	3/4	4	23/32	-	-	2T-80073	-	-	-

TURNING TOOL POSITION SKETCHES

1. (a) LEAD ANGLE, -5°, -10°, or -15° (Right Hand Shown)

Direction of Feed

5° POSITION ANGLE
Style, S 0-10

45° POSITION ANGLE
Style, S 30-50

85° POSITION ANGLE
Style, E 15

TURNING TOOL POSITION SKETCHES

1. (b) LEAD ANGLE, 0° (Right Hand Shown)

Direction of Feed

0° POSITION ANGLE
Style, S 0-10

45° POSITION ANGLE
Style, S 45-55

85° POSITION ANGLE
Style, E 5

TURNING TOOL POSITION SKETCHES

1. (c) LEAD ANGLE, 5°, 10°, or 15° (Right Hand Shown)

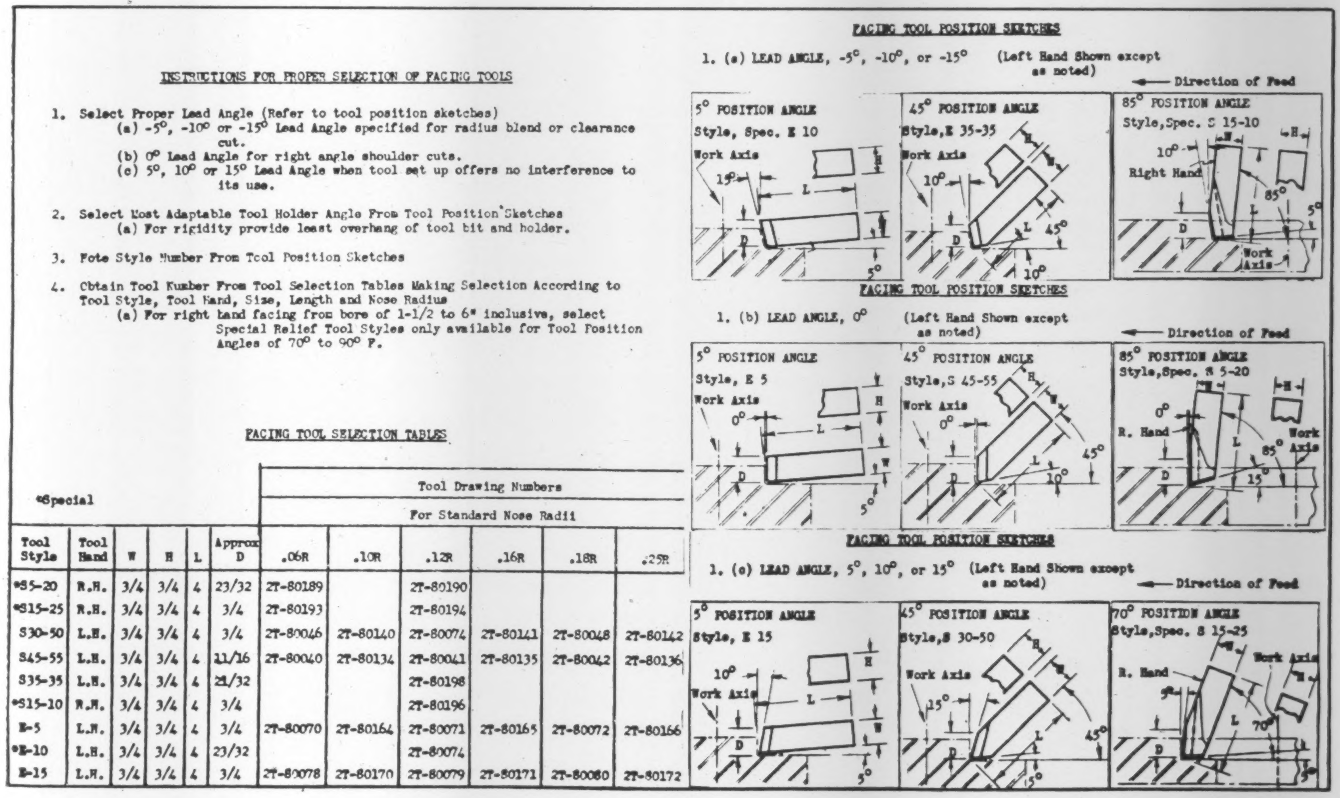
Direction of Feed

0° POSITION ANGLE
Style, S 15-10

45° POSITION ANGLE
Style E 35-35

85° POSITION ANGLE
Style, Spec. E 10

FIG. 3 SAMPLE PAGE FROM TURNING-TOOL STANDARDS



INSTRUCTIONS FOR PROPER SELECTION OF FACING TOOLS

1. Select Proper Lead Angle (Refer to tool position sketches)
   - (a) -5°, -10° or -15° Lead Angle specified for radius blend or clearance cut.
   - (b) 0° Lead Angle for right angle shoulder cuts.
   - (c) 5°, 10° or 15° Lead Angle when tool set up offers no interference to its use.
2. Select Most Adaptable Tool Holder Angle From Tool Position Sketches
   - (a) For rigidity provide least overhang of tool bit and holder.
3. Note Style Number From Tool Position Sketches
4. Obtain Tool Number From Tool Selection Tables Making Selection According to Tool Style, Tool Hand, Size, Length and Nose Radius
   - (a) For right hand facing from bore of 1-1/2 to 6" inclusive, select Special Relief Tool Styles only available for Tool Position Angles of 70° to 90° F.

FACING TOOL SELECTION TABLES

*Special

						Tool Drawing Numbers					
						For Standard Nose Radii					
Tool Style	Tool Hand	W	H	L	Approx D	.06R	.10R	.12R	.16R	.18R	.25R
*S5-20	R.H.	3/4	3/4	4	23/32	2T-80189		2T-80190			
*S15-25	R.H.	3/4	3/4	4	3/4	2T-80193		2T-80194			
S30-50	L.H.	3/4	3/4	4	3/4	2T-80046	2T-80140	2T-80074	2T-80141	2T-80048	2T-80142
S45-55	L.H.	3/4	3/4	4	11/16	2T-80040	2T-80134	2T-80041	2T-80135	2T-80042	2T-80136
S35-35	L.H.	3/4	3/4	4	21/32			2T-80198			
*S15-10	R.H.	3/4	3/4	4	3/4			2T-80196			
E-5	L.H.	3/4	3/4	4	3/4	2T-80070	2T-80164	2T-80071	2T-80165	2T-80072	2T-80166
*E-10	L.H.	3/4	3/4	4	23/32			2T-80074			
E-15	L.H.	3/4	3/4	4	3/4	2T-80078	2T-80170	2T-80079	2T-80171	2T-80080	2T-80172

FACING TOOL POSITION SKETCHES

1. (a) LEAD ANGLE, -5°, -10°, or -15° (Left Hand Shown except as noted)

← Direction of Feed

5° POSITION ANGLE
Style, Spec. E 10

45° POSITION ANGLE
Style, E 35-35

85° POSITION ANGLE
Style, Spec. S 15-10

FACING TOOL POSITION SKETCHES

1. (b) LEAD ANGLE, 0° (Left Hand Shown except as noted)

← Direction of Feed

5° POSITION ANGLE
Style, E 5

45° POSITION ANGLE
Style, S 45-55

85° POSITION ANGLE
Style, Spec. S 5-20

FACING TOOL POSITION SKETCHES

1. (c) LEAD ANGLE, 5°, 10°, or 15° (Left Hand Shown except as noted)

← Direction of Feed

5° POSITION ANGLE
Style, E 15

45° POSITION ANGLE
Style, S 30-50

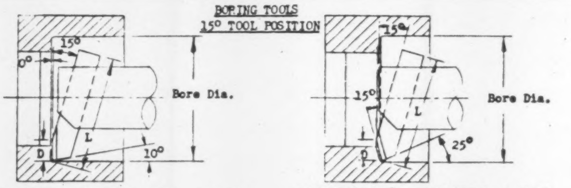
70° POSITION ANGLE
Style, Spec. S 15-25

FIG. 4 SAMPLE PAGE FROM FACING-TOOL STANDARDS

FIG. 5 SAMPLE PAGE FROM BORING-TOOL STANDARDS

INSTRUCTIONS FOR PROPER SELECTION OF BORING TOOLS

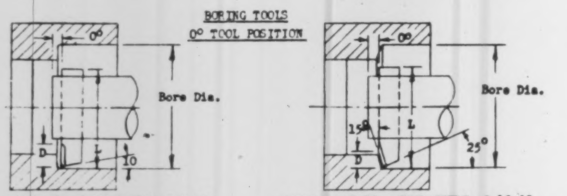
1. Select Desired Tool Position: 0°, 15°, 30° or 45°
2. Select Proper Lead Angle and Note Tool Style Number
   (a) Specify 0° lead angle for square shoulder
   (b) Use positive lead angle for all other conditions
3. Select Tool Number According to Tool Style, Meeting Requirements for Bore Diameter, Tool Size and Nose Radius



BORING TOOLS
15° TOOL POSITION

LEAD ANGLE 0°; TOOL STYLE, S 15-25 LEAD ANGLE 15°; TOOL STYLE, S 30-40

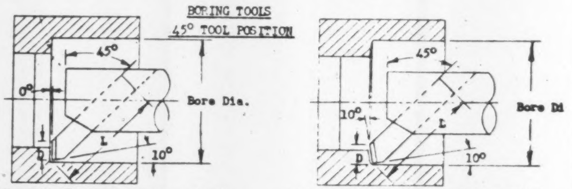
TOOL NO.	TOOL NO.	TOOL SIZE	BORE DIA.	NOSE RAD.	D	D	L	L	END CLEARANCE	
Style S 15-25	Style S 30-40				Style S 15-25	Style S 30-40	Style S 15-25	Style S 30-40	Prim.	Sec.
2T-91361	2T-91386	1/2. Sq.	4 & up	.030	1/2	1/2	3-1/2	3-1/2	6°	25°
2T-91362	2T-91387	1/2 Sq.	2 to 4	.060	1/2	1/2	1-3/4	1-3/4	10°	25°
2T-91363	2T-91388	1/2 Sq.	4 & up	.060	1/2	1/2	3-1/2	3-1/2	6°	25°
2T-91364	2T-91389	1/2 Sq.	2 to 4	.120	1/2	1/2	1-3/4	1-3/4	10°	25°
2T-91365	2T-91390	1/2 Sq.	4 & up	.120	1/2	1/2	3-1/2	3-1/2	6°	25°
2T-91366	2T-91391	5/8 Sq.	3 to 5	.060	5/8	5/8	2-3/4	2-3/4	10°	25°
2T-91367	2T-91392	5/8 Sq.	5 & up	.060	5/8	5/8	4	4	6°	25°
2T-91368	2T-91393	5/8 Sq.	3 to 5	.100	5/8	5/8	2-3/4	2-3/4	10°	25°
2T-91369	2T-91394	5/8 Sq.	5 & up	.100	5/8	5/8	4	4	6°	25°



BORING TOOLS
0° TOOL POSITION

LEAD ANGLE 0°; TOOL STYLE, S 0-10 LEAD ANGLE 15; TOOL STYLE, S 15-25

TOOL NO.	TOOL NO.	BORE DIA.	TOOL SIZE	NOSE RAD.	D	D	L	L	END CLEARANCE	
Style S 0-10	Style S 15-25				Style S 0-10	Style S 15-25	Style S 0-10	Style S 15-25	Prim.	Sec.
2T-91328	2T-91353	1 to 1½	1/4 Sq.	.030	1/4	1/4	7/8	7/8	15°	30°
2T-91329	2T-91354	1½ & up	1/4 Sq.	.030	1/4	1/4	1-1/4*	1-1/4*	10°	25°
2T-91330	2T-91355	1¼ to 2	5/16 Sq.	.030	5/16	11/32	1-1/8	1-1/8	15°	30°
2T-91331	2T-91356	2 & up	5/16 Sq	.030	5/16	11/32	1-1/2	1-1/2	10°	25°
2T-91332	2T-91357	1½ to 2	3/8 Sq.	.030	3/8	11/32	1-1/4	1-1/4	15°	30°
2T-91333	2T-91358	2 to 3	3/8 Sq.	.030	3/8	11/32	1-3/4	1-3/4	10°	25°
2T-91334	2T-91359	3 & up	3/8 Sq.	.030	3/8	11/32	2-1/2	2-1/2	10°	25°
2T-91335	2T-91360	2 to 4	1/2 Sq.	.030	1/2	15/32	1-3/4	1-3/4	10°	25°



BORING TOOLS
45° TOOL POSITION

LEAD ANGLE 0°; TOOL STYLE, S 45-55 LEAD ANGLE 10°; TOOL STYLE, E 35-35

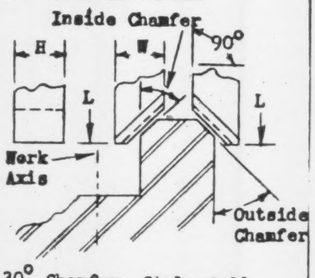
TOOL NO.	TOOL NO.	TOOL SIZE	BORE DIA.	NOSE RAD.	D	D	L	L	CLEARANCE	
Style S 45-55	Style E 35-35				Style S 45-55	Style E 35-35	Style S 45-55	Style E 35-35	Prim.	Sec.
2T-91420	2T-91445	5/8 Sq.	3 to 5	.120	5/8	19/32	3	3	10°	25°
2T-91421	2T-91446	5/8 Sq.	5 & up	.120	5/8	19/32	4-1/2	4-1/2	6°	25°
2T-91422	2T-91447	3/4 Sq.	4 to 6	.060	23/32	11/16	4	4	10°	25°
2T-91423	2T-91448	3/4 Sq.	6 & up	.060	23/32	11/16	5	5	6°	25°
2T-91424	2T-91449	3/4 Sq.	4 to 6	.100	23/32	11/16	4	4	10°	25°
2T-91425	2T-91450	3/4 Sq.	6 & up	.100	23/32	11/16	5	5	6°	25°
2T-91426	2T-91451	3/4 Sq.	4 to 6	.120	23/32	11/16	4	4	10°	25°
2T-91427	2T-91452	3/4 Sq.	6 & up	.120	23/32	11/16	5	5	6°	25°

FIG. 6 SAMPLE PAGE FROM CHAMFERING-TOOL STANDARDS

INSTRUCTIONS FOR PROPER SELECTION OF CHAMFER TOOLS

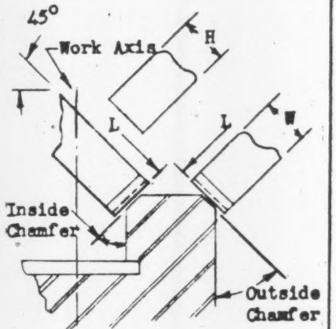
1. Select Most Adaptable Tool Position Angle To Cut Desired Chamfer.
2. Obtain Tool Number for 30°, 45° or 60° Chamfers from Tool Selection Tables, Selecting Tool According to Size, Tool Position Angle, and Inside or Outside Chamfers.

90° POSITION ANGLE



30° Chamfer; Style S-30
45° Chamfer; Style S-45
60° Chamfer; Style E-30

45° POSITION ANGLE



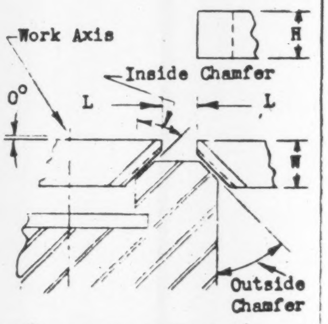
30° Chamfer; Style E 15
45° Chamfer; Style E 0
60° Chamfer; Style E 15

CHAMFER TOOL SELECTION TABLES

Follow instructions on sheet #29 in the selection of tools.

W	H	L' Inside Chamfer	L' Outside Chamfer	Position Angle A	Min. Bore Inside Chamfer	Tool Drawing Numbers for Common Chamfers					
						30°		45°		60°	
						Inside	*Outside	Inside	*Outside	Inside	*Outside
3/8	3/8	3/4	3	0°	1	5T-10731	5T-10666	5T-10733	5T-10668	5T-10735	5T-10670
3/8	3/8	-	3	10°	-	-	5T-10664	-	-	-	-
3/8	3/8	3	3	15°	1	5T-10729	5T-10662	5T-10731	5T-10666	5T-10733	5T-10668
3/8	3/8	-	3	25°	-	-	-	-	5T-10664	-	-
3/8	3/8	3	3	30°	1	5T-10730	5T-10660	5T-10729	5T-10662	5T-10731	5T-10666
3/8	3/8	-	3	40°	-	-	-	-	-	-	5T-10664
3/8	3/8	3	3	45°	1	5T-10732	5T-10661	5T-10730	5T-10660	5T-10729	5T-10662
3/8	3/8	-	3	50°	-	-	5T-10663	-	-	-	-
3/8	3/8	3	3	60°	1	5T-10734	5T-10665	5T-10732	5T-10661	5T-10730	5T-10660
3/8	3/8	-	3	65°	-	-	-	-	5T-10663	-	-
3/8	3/8	3	3	75°	1	5T-10736	5T-10667	5T-10734	5T-10665	5T-10732	5T-10661
3/8	3/8	-	3	80°	-	-	-	-	-	-	5T-10663
3/8	3/8	3	3	90°	1	5T-10738	5T-10669	5T-10736	5T-10667	5T-10734	5T-10665

0° POSITION ANGLE



30° Chamfer; Style E 30
45° Chamfer; Style S 45
60° Chamfer; Style S 30

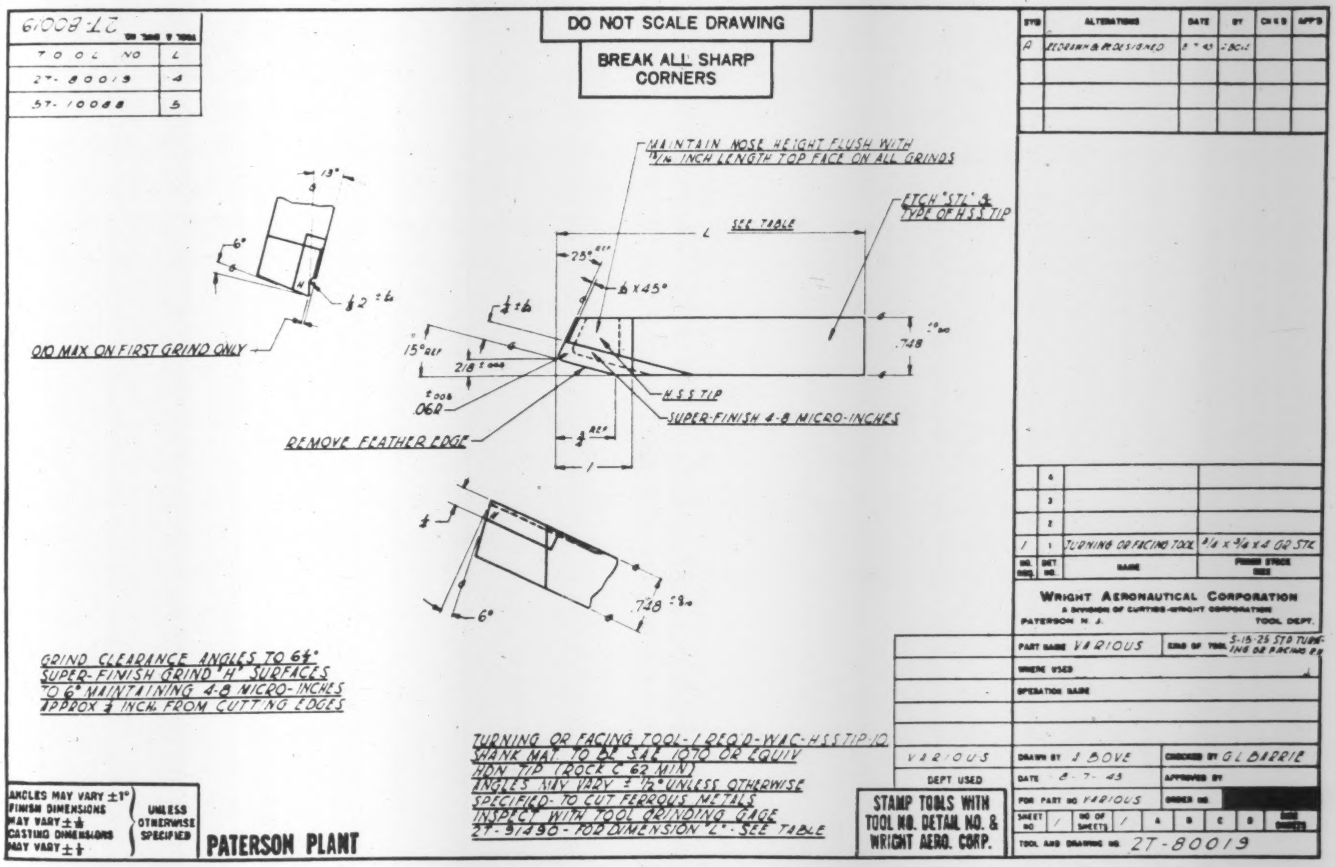

27-80019
TOOL NO L
27-80019 4
57-10088 5
DO NOT SCALE DRAWING
BREAK ALL SHARP CORNERS
A REDRAWN & REDESIGNED
MAINTAIN NOSE HEIGHT FLUSH WITH 11/16 INCH LENGTH TOP FACE ON ALL GRINDS
13°
6°
1/32 ±1/64
010 MAX ON FIRST GRIND ONLY
ETCH "STL" & TYPE OF H.S.S TIP
L SEE TABLE
25° REF
1/64 X 45°
1/4 ±1/64
15° REF
218 ±.004
±.008 .06R
.748
H.S.S TIP
SUPER-FINISH 4-8 MICRO-INCHES
REMOVE FEATHER EDGE
1/2 REF
1
6°
.748
GRIND CLEARANCE ANGLES TO 6 1/4°
SUPER-FINISH GRIND "H" SURFACES TO 6° MAINTAINING 4-8 MICRO-INCHES APPROX 1/8 INCH FROM CUTTING EDGES
TURNING OR FACING TOOL-1 REQ'D-WAC-HSS TIP-10
SHANK MAT. TO BE SAE 1070 OR EQUIV
HDN TIP (ROCK C 62 MIN)
ANGLES MAY VARY ± 1/2° UNLESS OTHERWISE SPECIFIED- TO CUT FERROUS METALS
INSPECT WITH TOOL GRINDING GAGE 27-91490 - FOR DIMENSION "L" - SEE TABLE
ANGLES MAY VARY ±1° FINISH DIMENSIONS MAY VARY ±1/64 CASTING DIMENSIONS MAY VARY ±1/8 UNLESS OTHERWISE SPECIFIED
PATERSON PLANT
VARIOUS
DEPT USED
STAMP TOOLS WITH TOOL NO. DETAIL NO. & WRIGHT AERO. CORP.
1 1 TURNING OR FACING TOOL 3/4 x 3/4 x 4 GR STK
NO. REQ. DET NO. NAME
WRIGHT AERONAUTICAL CORPORATION
A DIVISION OF CURTISS-WRIGHT CORPORATION
PATERSON N. J. TOOL DEPT.
PART NAME VARIOUS
KIND OF TOOL 5-15-25 STD TURNING OR FACING
WHERE USED
OPERATION NAME
DRAWN BY J BOVE
CHECKED BY G L BARRIE
DATE 8-7-43
APPROVED BY
FOR PART NO VARIOUS
ORDER NO
SHEET NO 1 NO OF SHEETS 1 A B C D
TOOL AND DRAWING NO. 27-80019

FIG. 7 SAMPLE TOOL DRAWING

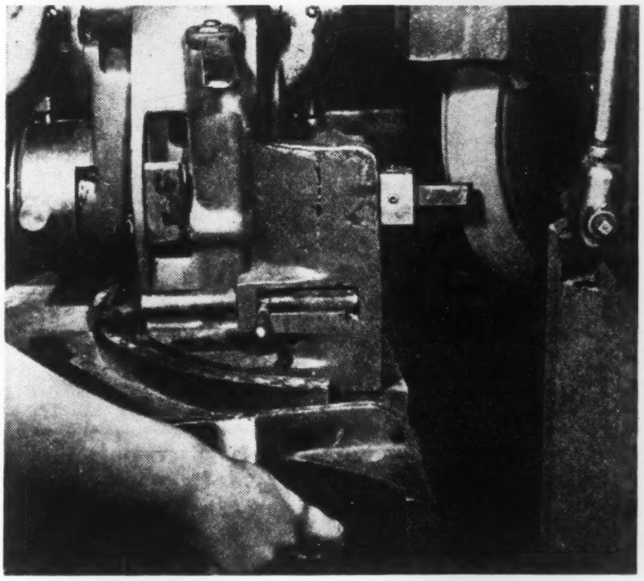


FIG. 8 SELLERS TUB GRINDER ROUGH-GRINDING SIDE AND END FACES

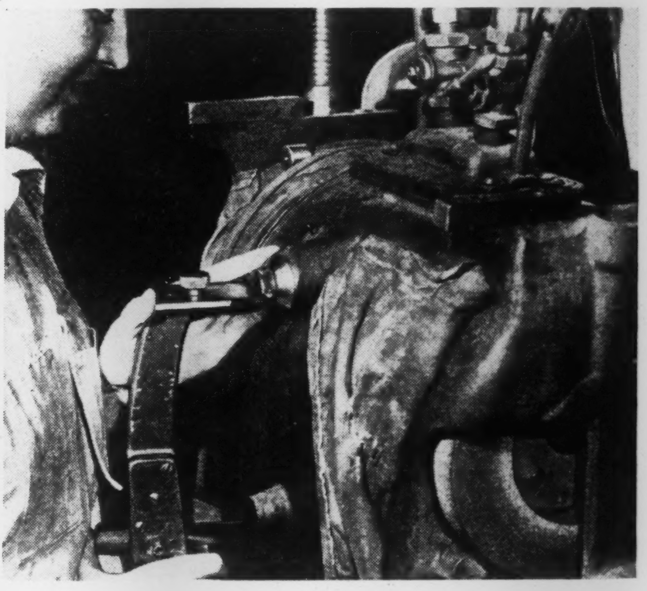


FIG. 9 OLIVER GRINDER TOOL SETUP AND SEMIFINISH GRINDING OF THE NOSE RADIUS, SIDE AND END FACES

Figs. 9 and 10 show the setup and semifinish grinding of the nose radius, side and end faces on the Oliver grinder using a soft fine-grain vitrified-bond aluminum-oxide wheel (Norton 3846-K5-BE). The chip breaker is ground first on the surface grinder using a very soft medium-grained vitrified-bond aluminum-oxide wheel (Norton 3846-18BE), and then finished on the same machine using a medium-hard very fine vitrified-bond aluminum-oxide wheel (Norton 38220-L9BE).

Fig. 11 shows the operation of finishing side, end faces, and nose radius on the Excello grinder using a medium-hard very fine vitrified-bond aluminum-oxide wheel (Norton 38220-L9BE).

The first step in the development of a simplified multiple-tool bit-grinding fixture for production grinding of tools is illustrated in Fig. 12. This fixture is equipped with replaceable templates to accommodate the various angles and can be set

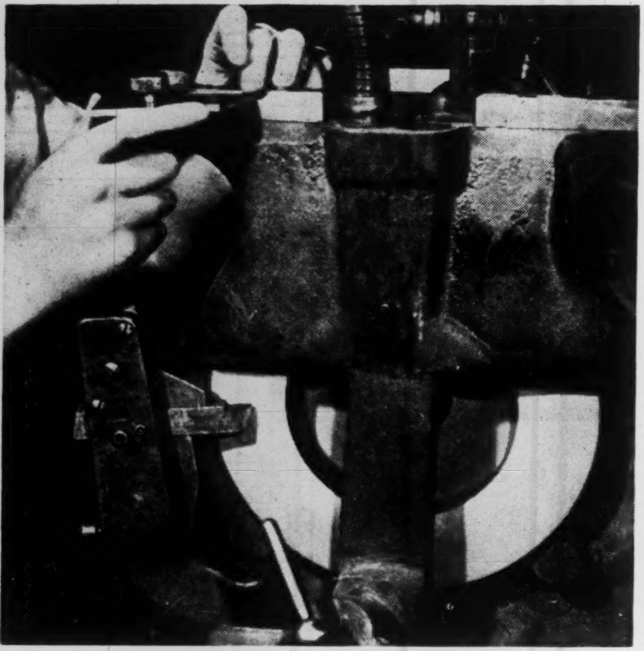


FIG. 10 OLIVER GRINDER SEMIFINISH GRINDING SIDE AND END FACES AND NOSE RADIUS

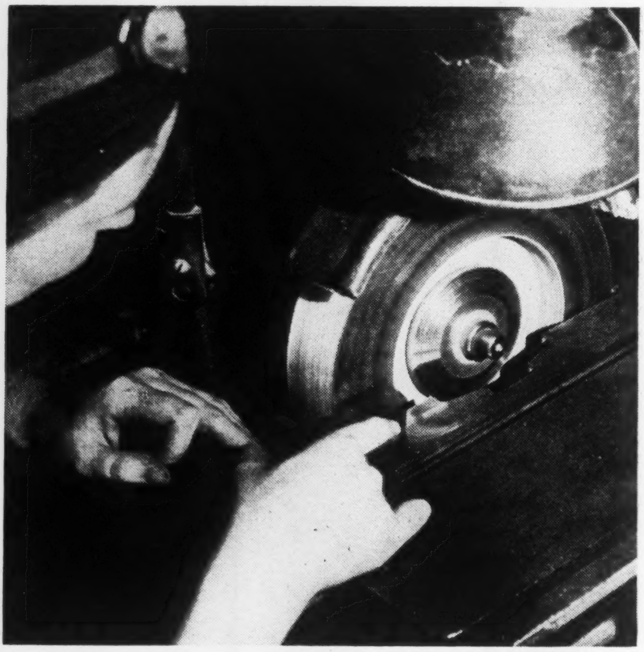
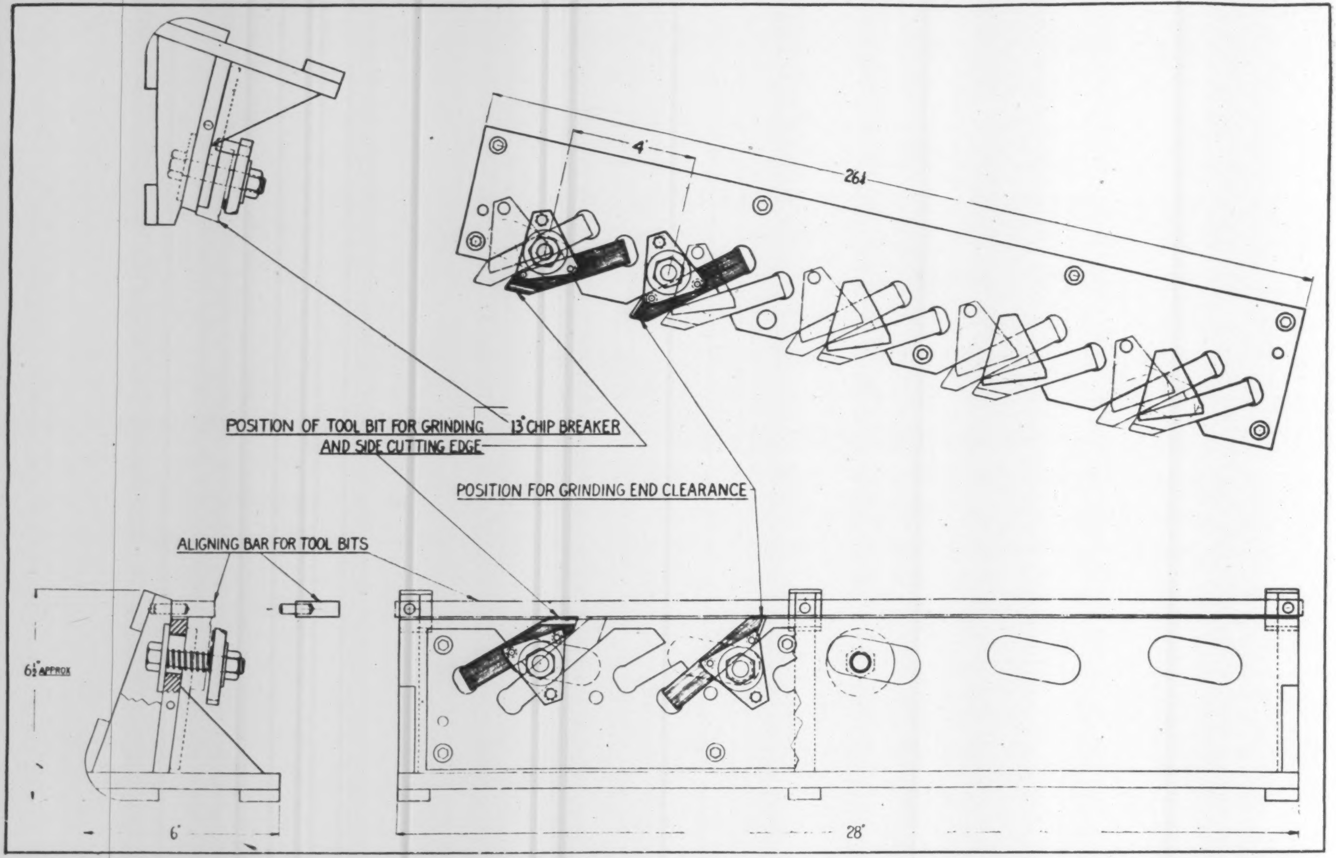


FIG. 11 EXCELLO GRINDER FINISHING SIDE AND END FACES AND NOSE RADIUS



4"
261
POSITION OF TOOL BIT FOR GRINDING 13° CHIP BREAKER AND SIDE CUTTING EDGE
POSITION FOR GRINDING END CLEARANCE
ALIGNING BAR FOR TOOL BITS
6½" APPROX
6"
28"

FIG. 12 MULTIPLE UNIVERSAL TOOL BIT-GRINDING FIXTURE, USED ON STANDARD SURFACE GRINDER

up on a surface grinder to grind the chip breaker, side and end angles in two settings of the tool bit. With the use of this fixture, the complete grinding can be accomplished with a surface grinder and the Excello, thus eliminating the Oliver grinder.

The fundamental principal of the later development of the multiple-grinding fixture is based upon generation of the main cutting-tool angles and the nose radius. Figs. 13 and 14 illustrate this fixture.

The tools which must be identical with respect to size, end and side cutting-edge angles, and nose radius, are placed in the fixture and oscillated about a predetermined center through the angle required to produce the desired nosradius and cutting-edge angles.

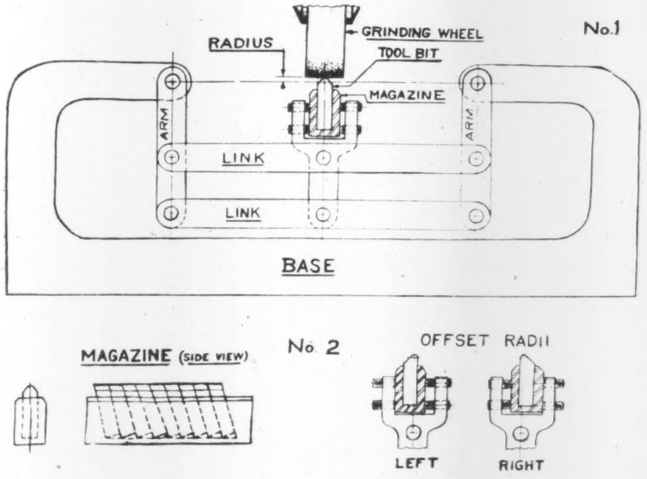


FIG. 13 MULTIPLE-GRINDING-FIXTURE SETUP FOR NOSE GRINDING

All tools are ground in a centralized grinding room. After grinding, the finished tool is placed in a suitable individual carton which protects the keen cutting edges and fine-finished surfaces from damage. The finished tool is inspected to blueprint dimensions by means of gages. Tool cribs are located at strategic positions on the shop floor from which the inspected tools are distributed to the operators.

Fig. 15 shows a properly marked tool and carton with a number of tools stored at one of the tool cribs. The operator has been instructed to return his used tools to the crib before complete breakdown and to replace them with new tools. This setup eliminates all grinding of tools by the operator.

Fig. 16 shows the machine-ground tools as applied to a Bullard Mult-Au-Matic machining a gear. This application showed a 6 to 1 improvement in tool life over operator-ground tools.

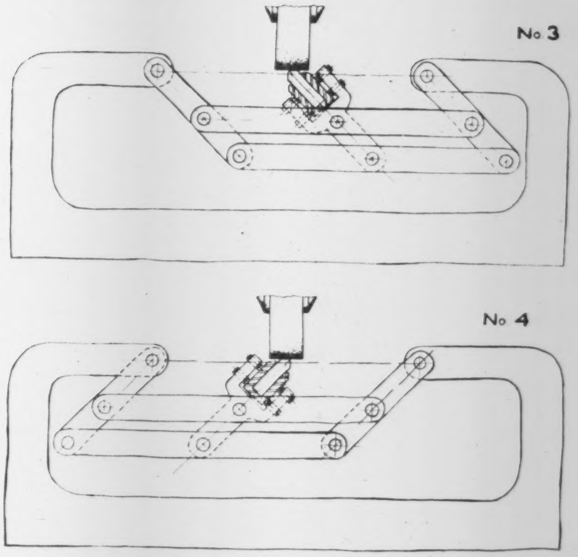


FIG. 14 MULTIPLE-GRINDING-FIXTURE SETUP FOR GRINDING END FACE

STANDARDIZATION OF SINTERED-CARBIDE TOOLS

Relative to standardization of carbide-tipped tools, the setup is similar to that used for H.S.S. instructions; tool-position sketches and tables being included with each class of tools. The nose radii have been limited to 5 values between 0.015 and 0.120 in. Chip-breaker design is divided in two types, namely,

TABLE 1 TOOL-DESIGN INVESTIGATION

Features of $^3/_4$-in. square tools

	Tool-design numbers									
Chip-Breaker nomenclature	1	2	3	4	5	6	7	8	9	10
Back rake, deg	5	0	5	0	5	5	0	0	0	5
Width, in	$^3/_{16}$	$^1/_4$	$^1/_4$	$^1/_4$	$^1/_4$	$^3/_{16}$	$^3/_{16}$	$^1/_4$	$^1/_4$	$^1/_4$
Side shoulder angle, deg	21	15	15	21	21	21	21	15	15	21
Radius, in	$^3/_{64}$	$^1/_8$	$^1/_8$	$^1/_8$	$^1/_8$	$^1/_8$	$^1/_8$	...	$^1/_8$	$^1/_8$
Depth, in	$^3/_{16}$	$^3/_{64}$	$^3/_{64}$	$^3/_{64}$	$^3/_{64}$	$^3/_{64}$	$^3/_{64}$	$^1/_{16}$	$^1/_4$	$^1/_4$
Lip radius, in	...	...	...	...	...	...	...	$^5/_{32}$	...	...
Top-face back rake, deg	5	...	...	...	...	...	...	...	...	...
Top-face side rake, deg	13	...	...	...	...	...	...	...	...	...

Features common to each of the designs tabulated:

13-deg side rake on chip controller	26-deg end-cutting-edge angle
6-deg side and end clearance	15-deg side-cutting edge angle

$^1/_{16}$-in. nose radius

TABLE 2 CONDITIONS AND RESULTS OF TESTS

[AMS 6250—Brinell 207—normalized and annealed; speed 105 fpm; feed 0.015 in; depth of cut $^3/_8$ in.] [AMS 6470—Brinell 285/311—quenched and drawn-speed 60 fpm; feed 0.015 in; depth of cut $^3/_8$ in.]

	Tool life, in.		Surface finish*				Absorbed power (K.W.)			
AMS specification no.	Nitralloy AMS 6470		Nitralloy AMS 6470		AMS 6250 SAE 3312		Nitralloy 6470		AMS 6250 SAE 3312	
WAC Coolant†	3AB	61	3AB	61	3AB	61	3AB	61	3AB	61
Design No. 1	41	..	a	c	c	c	2.40	2.70	3.70	4.30
Design No. 2	40	30	a	b	a	c	2.55	2.90	3.80	4.00
Design No. 3	25.5	..	a	b	a	d	2.50	2.90	3.70	3.95
Design No. 4	..	..	a	b	a	d	2.55	2.90	3.75	4.45
Design No. 5	..	..	a	b	a	d	2.50	2.90	3.70	4.15
Design No. 6	..	..	a	e	d	.	2.60	3.05	3.65	..
Design No. 7	..	..	a	c	c	..	2.60	3.15	3.60	..
Design No. 8	..	..	..	..	..	..	..	3.05	4.50	..
Design No. 9	..	..	..	..	..	..	..	3.25	..	..
Design No. 10	Excessive load—test stopped									

* Surface-finish legend: a—very good; b—good; c—fair; d—poor; e—very poor.

† 3AB—sulphurized-oil blend (5:1); 61—soluble-oil emulsion (12:1).

8-deg angular-step type in $^{1}/_{16}$, $^{3}/_{32}$ $^{1}/_{8}$, and $^{5}/_{32}$ in. widths; parallel-step type in $^{3}/_{32}$, $^{1}/_{8}$, and $^{5}/_{32}$, and $^{3}/_{16}$ in. widths.

At present four manufacturers of carbides have been approved as suppliers of T.C. tools for cutting steel and nonferrous metals, i.e., aluminum, magnesium, brass, and bronze. Seven standard stock styles are purchased to make approximately 26 tool styles.

Four grade specifications are recommended for machining steel and four grades for cutting nonferrous materials. The four grades are specified as follows:

1 Majority of roughing and finishing operations.

2 Light-finishing cuts where ability to hold size is important.

3 Intermittent cuts.

4 Precision boring.

CONCLUSION

The use of style numbers for identification makes it possible for the operator to obtain tools from the tool crib by style number, size, and nose radius, in the same manner that he would request a drill, reamer, etc. It is believed that the metal industry as a whole will derive a great many benefits from the proper application of standard single-point cutting tools. In standardizing tool holders, it is suggested that machine-tool manufacturers select the same angles, keeping these to a minimum and eliminating the use of dovetail tools.

It is hoped that the standards developed by the Wright Aeronautical Corporation will arouse enough interest among the manufacturers to make them consider similar standards for use by the industry at large.

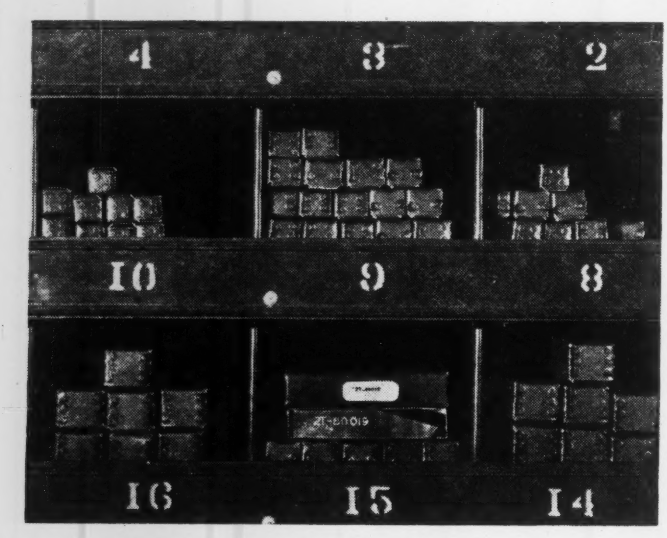


FIG. 15 VIEW OF TOOL CRIB; A PROPERLY MARKED CARTON AND FINISHED TOOL ARE ALSO SHOWN

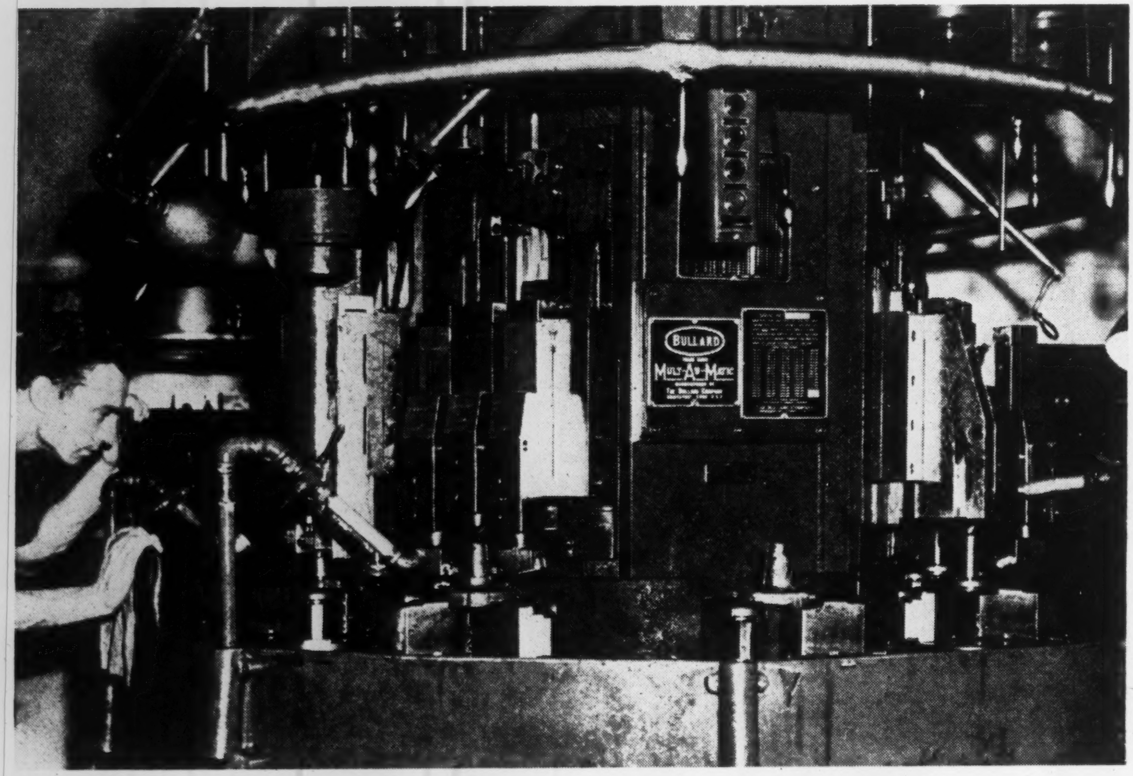


FIG. 16 MACHINE-GROUND TOOLS APPLIED TO BULLARD AUTOMATIC GEAR-CUTTING MACHINE

FUELS *and* FUEL RESEARCH *in* GREAT BRITAIN *During the* WAR[1]

By W. C. SCHROEDER

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During a period of national emergency much of the long-range, and to a considerable extent the most interesting, research must be held in abeyance in favor of problems of immediate importance that may be solved quickly. This, of course, has happened in Great Britain, but on the other hand the war period has fostered considerable planning for the future that will affect British policy to a marked extent after the war. Some of the primary items of immediate importance are the development of automotive gas producers, effect of the war on coal production, the fuel-economy campaign, development of efficient fireplaces, and the study of colloidal fuel. Three of the longer-range items are correlation of coal properties with heat of wetting and reflective indexes and the production of liquid fuels from coal.

AUTOMOTIVE GAS PRODUCERS

The gasoline rationing that the American public endures is mild compared with that in Great Britain. Since all liquid fuels must be imported (with the exception of small amounts produced from low-temperature distillation, from oil shale, or from coal hydrogenation) it is literally a choice between gasoline or food and ammunition. All pleasure driving is banned, and on Sundays or holidays the police stop private cars at frequent intervals to determine the purpose for which they are being used. Gasoline can be obtained only to to go to work in essential industries when the distance to be traveled is greater than two or three miles and when absolutely no public transportation is available. Perhaps the severity of the rationing is indicated best by the case of one of the engineers of Imperial Chemical Industries who regularly rode a bicycle 16 miles to work, which apparently was easier than reasoning with the ration board. This engineer was carrying on his normal administrative duties, doing his regular stint at home guard, and cycling 32 miles a day without complaint, except that he felt somewhat aggrieved when he had to face a head wind all the way home.

Since much of the gasoline and some of the shipping are provided from the United States it is of interest that the Petroleum Attaché's office of our Embassy takes an active part in seeing that gasoline is used only in essential war activities. At the same time, this office limits its own use of gasoline to a bare minimum. It has only one car, which is not driven over 15 miles a day. After that appointments are kept by subway, bus, or on foot.

Naturally, these severe limitations have resulted in casting about to find other means of providing automotive transportation. Gas stored in huge bags on top of the cars, liquefied gases, portable gas producers, and other schemes are used. The most promising are probably gas producers. These have been developed extensively and are in common use in Germany, France, Sweden, and other European countries. The most successful units usually have operated on wood charcoal.

The gas producers used in these countries differ considerably in appearance but operate in essentially the same manner. Air, frequently with added water vapor, is pulled through the combustion zone by the suction of the engine, where a reaction takes place to form carbon monoxide and hydrogen. The amount of hydrogen depends largely on the amount of water vapor added as well as the moisture content of the fuel. The gas is cooled, filtered (usually through a series of filters), mixed with air (frequently by hand control), and sent to the engine. As it leaves the producer, the gas normally has a heating value of 120 to 130 Btu per cu ft.

The usual criticisms of the gas producers in comparison with gasoline are: Slower starting, decrease in engine power to 50 or 60 per cent of normal, frequent refilling with charcoal, and generally inconvenient and cumbersome operation.

In Germany and France and to a lesser extent in Sweden, it already is apparent that this use of wood will place a severe demand on the forests. Great Britain is not as well situated with respect to forests as most of the European countries, and this has retarded adoption of the gas producer operating on wood. On the other hand, this shortage has supplied a strong incentive to develop a producer that would operate successfully on anthracite or specially prepared coke.

The use of these fuels presents four difficulties as compared with the use of charcoal. It introduces greater amounts of ash in the combustion zone, releases fly ash or dust which is difficult to remove from the gases going to the engine, is slower in response to a demand for increased rate of gasification, and may introduce tarry matter, which plugs filters.

The research in Great Britain has surmounted these difficulties to a considerable extent for their conditions. Equipment has been developed to use either anthracite or high-temperature coke. The latter fuel is still rather slow in responding to the demand for more gas, that is, it has a low reactivity, and some attempt has been made to improve it by activating the coke by spraying with sodium carbonate before use. This is believed to have some beneficial effect. Ash is removed by hand in the form of clinker, for the temperatures in the combustion zone are high enough to fuse it. To prevent excessive trouble and interference with combustion, the ash is limited to not more than 4 per cent with natural fuels and 6 per cent with carbonized fuels. Great Britain has anthracite that will meet this specification. It would be difficult to find or prepare such coal in quantity from the anthracite we have in the United States. Limited amounts of coal could be found to prepare low-ash coke. The fuels are used in prepared sizes from $^3/_4$ to $^1/_4$ in.

These producers are of the cross-draft type and up-draft type, but the former is most popular. A single tuyère is used in the cross-draft producer, and the combustion zone is limited to a radius of about 4 to 6 in. to give a hot fire in a short time and to help the producer respond more quickly to increased demand. The air is preheated to about 80 C (176 F) by a heat exchanger and in some cases is nearly saturated with water vapor. The hot gases leaving the producer pass through the other side of the heat exchanger and then through a cooler and filter. In one type of cleaner, the cooled gas is passed through a water-filled chamber and again filtered, giving a gas containing so little

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[1] Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior.

Contributed by the Fuels Division for presentation at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of The American Society of Mechanical Engineers.

solids that it is stated that engine wear is no greater than with gasoline. The high density, particularly of anthracite, will allow about 200 miles on one filling of the coal hopper.

To prevent excessive difficulty and plugging of the filter with tar, fuel specifications called for less than 11 ounces per ton for either the coke or anthracite.[2] The government started to use a few thousand of these producers for trucks and buses about the middle of this year. Progress since that time toward the more widespread use of this producer apparently has been rather slow.

DRAFTING OF COAL MINERS

The history of coal production in Great Britain during the war is not of direct concern with respect to research, but it is of considerable interest because of the close parallel with the conditions that now seem to be developing in the United States.

In the early part of the war, when conscription first was introduced, the miners were subject to the draft. This policy was followed for some time, but it was realized ultimately that the country would not have enough coal for industrial and domestic consumption if the miners were not kept at their jobs. The situation was aggravated further by the loss of miners to industries that provided more agreeable working conditions and higher pay.

As soon as it became apparent that England was going to suffer a coal shortage, all of the men were registered who had worked in mines for 6 months or longer since 1935, and who were not then engaged in mining. Of a total of over 100,000 it was found that 50,000 were in jobs as important or more important than mining. About 20,000 or 25,000 were physically disqualified, and the remainder—about 25,000—were returned to the mines. This step helped for a while, but it did not provide a sufficient number of additional men to get out the coal needed.

In common with other industries in England, the miners were frozen in their jobs. This step soon revealed that the natural wastage of manpower from retirement, ill health, and death was much larger than was expected. In Great Britain, of a total of about 700,000 miners the natural wastage was approximately 38,000 annually. From this figure it is apparent that the 25,000 men returned to the mines by the first step of registration were not even sufficient to replace the normal annual wastage in manpower.

As the next step to augment mine labor, all the men in the armed forces who ever had worked as miners were required to register. Of approximately 100,000 men registered, it was found that one half were officers or were serving overseas and could not be returned to the mines. Another fourth were judged to be so important in the army that they could not be released. In all, about 20,000 men were returned to the mines.

To comb the country still further, a board of doctors was organized to examine the health certificates that had been issued to the miners by local doctors. By this means, together with rehabilitation of the health of some miners, it was found possible to return a few more thousand men to mining work.

In the next step to secure additional miners, men between the ages of 18 and 21 drafted for the armed forces were permitted to choose between going into the mines or into the army. This has not provided any very large number of men, apparently because they would rather be soldiers than miners. It is my understanding that the age limits in which men are permitted this selection have now been broadened.

Production per man-day in British mines is relatively low when compared with American standards. This seems to be due to a variety of causes, including thin seams, less mechanization, older mines, and different mining methods. Neither output per man nor total coal production for the nation has been increased materially during the war. In fact, the shortage of manpower is making it difficult to maintain even present annual production. Great Britain and the United States have been exchanging ideas on coal production and mining methods through visits of mining people to both countries. This may help to increase daily output of the British miners.

This history of the manpower policy in the mines is quite similar to the situation that has existed in the United States. At present, however, there appears to be a growing realization that coal production must be maintained if our industrial economy is to operate efficiently.

FUEL-ECONOMY CAMPAIGN

The shortage of coal in Great Britain has resulted in a vigorous fuel-economy campaign. The first step taken last winter was a blanket cut of $7^1/_2$ per cent to industrial users. The need for saving coal is emphasized on both the domestic and industrial fronts. A well-organized and widespread publicity campaign keeps house owners conscious of their part in the program. Examples are: Not over 5 in. of water for a bath, a limited number of baths per week, avoidance of all waste of water and electricity, doors kept closed, house temperatures maintained below 60 F, and similar items, in which the general public can co-operate. Posters and signs are used liberally to stress the importance of doing all possible to save fuel.

Although the economy campaign respecting the public has been strong, it is, in a comparative sense, a side line of the powerful attack directed to the saving of fuel in industry. This can be judged by the Conference on the Utilization of Steam, Heat, and Power, held on May 12 and 13, 1943. There were 781 fuel engineers at this conference (in 1942 there were only about 200). The opening address was given by the Minister of Fuel and Power, Rt. Hon. Owilyn Lloyd George, M.P. He stated that there had been an anticipated deficiency of 11 million tons of coal for 1942 and that the fuel-economy campaign had been responsible in a major degree for the success with which this gap between demand and production had been bridged. He also called attention to the success that had been attained in building up a country-wide voluntary organization.

The speakers who followed outlined the organization, the approach to the work, or the methods followed to secure fuel economy. One noted that the present organization was based on the experience of a small fuel-economy committee that had functioned previously in North Wales. This speaker also called attention to the early difficulties anticipated in their work. First, they doubted if they could enlist the voluntary effort of competent men; second, there was considerable question as to how industry would receive the people sent to them; and third, there was some doubt that industry would act on any advice offered. The success of the fuel-economy work indicates that none of these difficulties proved to be too serious.

A National Advisory Committee composed of 12 fuel engineers, particularly selected because of their prominence, has helped to guide the work of the Fuel Efficiency Committee. Dr. E. S. Grumell, of Imperial Chemical Industries, is chairman of this group. Dr. W. A. McFarlane, of the Ministry of Fuel and Power, is responsible for execution of policies laid out.

For the purpose of the fuel-economy work, Great Britain is divided into 12 regions with a regional controller and a separate subcommittee of the fuel-efficiency committee assigned to each. The regional controller is responsible for organization of the district work and makes weekly reports to the Ministry of Fuel and Power. The regional controller has one to three fuel engineers (32 technical men[3] are distributed in the 12 regions) under his direction. The individual industry in the region may report directly to the regional controller or through its trade association. Trade associations frequently organize their own fuel-efficiency committees.

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[2] Complete specifications for transport producer-gas fuels have been published in *Automobile Engineer*, Nov. 5, 1942 (special issue), p. 427.

[3] The men for this work were secured by solicitation of coal companies and industries to find fuel engineers that could be released. Each man was given instruction and training.

Within individual plants or companies, an attempt has been made to find one engineer who would be responsible for the fuel-economy campaign. He appointed fuel watchers throughout his organization, who were instructed as to steps that might be taken to save fuel. The regional controller was responsible for instructing these men. All work in the plants was voluntary. The companies co-operated fully. When necessary they allowed their men to leave work to attend classes, and frequently paid traveling expenses.

Education was found to be one of the most important points in the whole program. This was started with the management and carried into the plant. Special pamphlets and letters to the management from the regional committees were found most successful. When a satisfactory groundwork had been laid, classes were organized in the regions to educate the technical men. The co-operation obtained in this step depended primarily on how well the preliminary education had been brought home.

Within the plant, the first step in the campaign was to request rather broad information, such as the amount of coal used, the purposes for which it was used, and the product of the plant. After this a regional engineer visited the plant and reported to the regional committee. Recommendations that the committee approved were then sent to the plant. The regional engineer made periodic checks to determine the progress made in carrying out the recommendations and the result on fuel consumption.

It was found that heat-balance sheets over a whole plant were very useful. Within a given industry they allowed comparison of the over-all efficiency of the utilization of coal. They also inspired the technical men to try to achieve as good a result as the best men in their industry. A second similar scheme frequently followed was to calculate the amount of coal used per ton of product.

Great stress was laid on the possibilities for saving fuel in the utilization of steam, gas, or electricity. Savings possible in utilization were estimated to be three to four times greater than those that can be made during generation of steam or power.

The United States has achieved a much greater relative increase in coal production than was possible in Great Britain, and no severe coal shortage has been encountered so far. This winter it is believed conditions may be more difficult. If a voluntary fuel-economy program by industry in this country can help to prevent coal rationing certainly it would seem to be worth while.

FIREPLACES

Much of the heating in British homes is still done by open coal fires. There is also a strong body of opinion that this will continue to be true after the war in spite of the obvious advantages that Americans see in furnaces or other central heating plants for domestic comfort heating. This viewpoint, as well as the need for saving coal, has resulted in intensive experimentation to increase the heating efficiency of the fireplace.

Units have been developed in which air circulates around the brickwork to carry heat into the room. A register has been designed and tested which helps to secure rapid increase in combustion and then to hold it at the desired rate. The fires can be banked overnight, and the bed frequently is covered by a hood to prevent sparks flying into the room. Improvements have also been made in the design of open grates to increase the heat transferred to the room by radiation.

These units seem to represent a considerable advance over conventional fireplaces so far as efficiency is concerned. On the other hand, they detract generally from the aesthetic effect of the open fire.

COLLOIDAL FUEL

The use of mixtures of coal and oil has been a subject of interest in Great Britain ever since the war of 1914–1918. Most stationary boilers in that country operate on coal and a limited number use tar; almost none uses oil. On the other hand, a considerable proportion of the shipping does use oil; this is viewed as one of the primary outlets for colloidal fuel.

The liner *Scythia* of the Cunard Line made a trip about 1932 between New York and Liverpool in which one boiler out of six operated on colloidal fuel. This same liner made another trip about 1940. In both cases the fuel was reported to operate quite successfully, but there seems to have been little effort to use it on any considerable scale.

Powell Duffryn Associated Collieries[4] have carried out the latest and probably the most extensive tests on the preparation and utilization of colloidal fuel. This work has extended over the last 10 or 12 years and has included the operation of a pilot plant to produce about 20 tons of colloidal fuel a day.

The results show that the coal must be substantially free from particles that will not pass a 200-I.M.M. sieve (230 U. S. standard) and that it must be thoroughly wet by the oil and mixed with it. No coal-in-oil suspension was found perfectly stable. The stability decreased with decrease in coal content or fineness and with increasing temperatures. Tests and inspection of tanks and pipe lines have shown that suspensions adequately stable for all normal commercial requirements can be obtained by mixing 40–45 per cent coal, 99 per cent through 200-I.M.M. sieve (230 U. S. standard) with cracked residual oil of the bunker C type. No stabilizing agent or "fixateur" was used. Local overheating during storage must be avoided.

During this investigation, it was found that the coal and oil did not separate into two components after they were once mixed. What actually occurred was a graduation in coal concentration increasing from the top layer to a maximum of about 58 per cent in the bottom layer. Table 1 indicates the time required to attain a concentration of 45 and 58 per cent coal in the bottom layer (one-fifth of the total depth) at various temperatures for a suspension of 40 per cent coal (99 per cent through a 200-I.M.M. sieve) in bunker C oil. The mixed fuel is sufficiently stable for commercial use at ordinary storage temperatures.

TABLE 1 EFFECT OF TEMPERATURE ON INCREASE IN CONCENTRATION OF COAL IN BOTTOM LAYER

(60% oil; 40% coal, 99% through 200 I.M.M.)

Temperature, C	Time (days) to reach coal concentration in the bottom layer[a] of	
	45 Per cent	58 Per cent
15	More than 150	More than 500
30	Approximately 65–70	Approximately 240
50	Approximately 26	Approximately 85–90
70	Approximately 5	Approximately 17

[a] One fifth of total depth of mixture.

In the combustion tests the fuel gave no trouble. Mechanical, steam, or air atomizing burners were used successfully. Difficulty was not experienced with burner stoppages, loss of ignition, pumps, filters, or heaters. Performance was reported to be indistinguishable from that obtained when using fuel oil.

The results secured from this work in Great Britain agree in practically every respect with those recently reported by Barkley, Hersberger, and Burdick,[5] at the Joint A.I.M.E.-A.S.M.E. Fuels Conference in Pittsburgh. In both cases, it was found desirable to use about 40 per cent coal, pulverized 98–99 per cent through 230-mesh U. S. standard. In storage and pumping, local overheating must be avoided. The colloidal fuel could be handled satisfactorily by pumps and burners and performed much the same as oil in the furnace.

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[4] The information on this investigation was provided through the kindness of W. Idris Jones, Research Department, Powell Duffryn Associated Collieries, Ltd.

[5] Laboratory and Field Tests of Coal-in-Oil Fuels," by J. F. Barkley, A. B. Hersberger, and L. R. Burdick, presented at National Meeting of the A.S.M.E. Oil and Gas Power Division, Baltimore, Md., June 14–16.

From a practical standpoint the information for the successful use of colloidal fuel now seems to be available. It remains to be seen if this fuel will find any extensive application in either Great Britain or the United States.

MEASUREMENT OF INNER SURFACE OF COAL

The British Coal Utilization Research Association has extensive work under way to estimate the inner surface of coal through measurement of the heat of wetting. Methyl alcohol is used as the wetting agent because of its penetrating properties and rapid evolution of heat which permits accurate determination of the thermal effect.

The heat of wetting is around 7 calories per gram for coals such as anthracite with less than 8 or 10 per cent volatile matter. It decreased to about 2 to 4 calories per gram as the volatile matter increases to 15 to 25 per cent and then increases slowly as the volatile matter reaches 32 or 33 per cent and after that quite sharply to as high as 15 or 20 calories per gram for volatile content between 35 to 40 per cent.

It is believed that these measurements may be used to predict the coking properties of coal. Those British coals which have a small value for the heat of wetting (and consequently relatively low internal surfaces) compared with their volatile matter have the best coking properties. It would be interesting to know if that same relationship holds for American coals.

These measurements also can be used to estimate the effect of surface area in the rate of reaction of a solid fuel, for example in a combustion process. Preliminary calculations of the extent of the inner surfaces indicate values which seem to range up to a million square feet per pound of coal. This work may help to correlate some of the fundamental properties of solid fuels with their characteristics in utilization. In any attempt to do this, however, it must be clearly recognized that the extent of the inner surfaces may change rapidly during the utilization process itself.

MEASUREMENT OF REFLECTANCE OF COAL SURFACES

Another investigation being carried out in Great Britain, of importance with respect to understanding the fundamental nature and properties of coal, is the study of the reflectance of light from polished coal surfaces.[6] This work has been both the hobby and vocation of Dr. Seyler for many years, but progress was relatively slow until the measurements of reflectance were made in oil. A Berek microphotometer was adapted to the work by the development of a number of special features. The technique for polishing and examining the specimens is difficult and demands special training. The interpretation of the results, up to the present, is also rather involved.

This work has shown, however, that the reflectance does not vary continuously either with rank or the nature of the coal component. Instead, it changes by definite steps to form a series in which a constant ratio exists between the reflectance of any two successive members so that $R_0 = 0.261 \times 1.363^{N_R}$, where R_0 is the reflectance in cedar oil under specified conditions and N_R the percentage reflectance number, which is either zero or a whole number. This relation is stated to hold, both when the rank of the coal changes or when the nature of the component changes by steps intermediate between vitrinite and fusinite.[7] For example, for a single component such as vitrinite this relationship applies as the rank increases or decreases. Similarly, for coal of a given rank the reflectance changes by a series of definite steps as the component changes from vitrinite to fusinite. The components between these extremes provisionally are called intermediates. The total number of steps defined by measurement of reflectance is 9.

Dr. Seyler believes from his preliminary work that the reflective measurements can be correlated with the physical and chemical properties of coal, including its plastic and coking properties, as well as the way it responds to liquefaction through hydrogenation. Investigation to test these ideas is now going on.

The meaning of these measurements of reflectance, the reason for the change by definite increments or steps, as well as the limitation to nine steps, has not been made entirely clear. The author had the opportunity to spend a day with Dr. Seyler in discussion and exchange of ideas regarding this work. It is not the type of research that is easy to explain.

From the author's viewpoint, however, considerable confusion seems to have been added to the situation by trying to relate the results too closely to the geology of coal and to the terminology previously used to define the microcomponents. As a first step, it is of sufficient importance that the work so far has indicated nine components according to reflective measurements separated from each other by definite increments. The next step should be to show the relationship of these measurements to the physical and chemical properties of the coal, including plastic, coking, and combustion characteristics, and to use these results to help trace back the meaning of the measurements with respect to coal petrology.

LIQUID FUELS FROM COAL

Research work to convert coal to oil and gasoline started in Germany about 1913. By 1927 the work had progressed far enough to allow that country to embark on a full-scale commercial development. It is now believed that one half to two thirds of the gasoline Germany has available for fighting the war comes from these plants. Production comprises not only gasoline but Diesel oil, fuel oil, and a reasonably good grade of lubricating oil. Obviously, this whole development was part of the plan to make that country as self-sufficient as possible.

The British people were much less aggressive in their approach to the production of synthetic liquid fuels. The Fuel Research Station carried out a considerable amount of laboratory work on the Bergius process of coal hydrogenation. In this method, the coal is mixed with a heavy oil, a small amount of a catalyst such as tin oxide is added, and the mixture is pumped, with hydrogen, under high pressure into a converter. Here a partial conversion of the coal into heavy oil, light oil, and gases takes place. The product from this first step is separated into solid and liquid. Some of the heavy oil goes back to be mixed with the coal while the remainder goes on to a second stage of hydrogenation to increase the yield of light oil and gasoline.

In essence the process may be viewed as one of increasing the hydrogen content of coal. Bituminous coal normally contains around 5 or 6 per cent hydrogen and a small amount of oxygen. Petroleum contains around 13 per cent hydrogen. By subjecting coal to the action of hydrogen under high pressure and at temperatures near 470 C, in the presence of a catalyst, the oxygen is removed and the hydrogen content increased with the formation of a liquid fuel similar to petroleum. This process yields a gasoline with excellent antiknock properties.

About 1930, Imperial Chemical Industries became interested in the commercial development of coal hydrogenation in Great Britain. After extensive pilot-plant experiments, construction was started on a plant to produce about 3500 barrels of gasoline per day. At that time there was a full exchange of information with German engineers to take advantage of the progress that had been made in that country. This new plant was completed about 1935 or 1936 and has operated successfully since that time.

Through the kindness of Imperial Chemical Industries, we were permitted to make a detailed examination of the entire

(*Continued on page 892*)

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[6] Recent Progress in the Petrology of Coal, by Clarence A. Seyler, *Journal of the Institute of Fuel*, June, 1943, pp. 134–141. (Melchett Lecture for 1941.)

[7] Vitrinite is the main and characteristic component of vitrain and clarain, while fusinite is supposed to be the main and characteristic component of fusain.

DUST COLLECTORS *Constructed of* NONCRITICAL MATERIALS

By LOUIS C. WHITON

PRESIDENT, PRAT-DANIEL CORPORATION, EAST PORT CHESTER, CONN.

AS PART of its steel-conservation program, the War Production Board, in April, 1942, issued directives to continue through the emergency, recommending the omission of all internal parts of fly-ash-collecting equipment in land-boiler installations. It was quickly found, however, that these orders could not be followed completely, because various war-plant operations required a clean atmosphere in the area adjacent to the plant.

In many locations, it was found imperative to install dust collectors to protect the plant equipment and products from injury caused by fly ash returning with eddy currents in the atmosphere, and by wind reversals.

To determine whether dust collectors were considered essential for certain industrial operations, the author's company submitted a comprehensive questionnaire to various war plants. Many replies were received, 90 per cent of which indicated that such dust collectors were necessary. This was particularly the case in connection with plants manufacturing internal-combustion engines, and in such operations as the manufacture of explosives, where dust acts as a contaminating agent.

SEARCH FOR NONCRITICAL MATERIALS

The amount of steel ordinarily used in a dust collector varies considerably with the type of collector, of which there are the three following mechanical forms:

1 Apparatus used in connection with a fan, as part thereof.

2 Apparatus of a multicyclone type, consisting of a number of cyclones from 2 ft to 5 ft diam.

3 Tubular type, consisting of a large number of small centrifugal tubes of about 6 in. diam.

Upon receipt of the directive from the War Production Board, and at its suggestion, a study was started immediately to find means of substituting other material than steel in the construction of this apparatus. It was evident that the approach should be toward the use of ceramic material, since the supply of the raw product was unlimited, and it was probable that such material would never be considered critical.

The author's company manufactures all three types of dust collectors mentioned, but type 1, in which the apparatus is combined with the fan, was discarded as a possibility for the application of ceramicware in place of steel. In such apparatus the parts would be relatively large, and the ceramic manufacturers did not feel it to be commercially feasible to manufacture them.

The multicyclone type was also discarded for the same reason. The most practical application was, therefore, an apparatus utilizing small-diameter tubes, since the units could be made with a minimum of joints, and the type of manufacture was similar to that which has been practiced for many years by manufacturers of ceramicware, namely, pipes and tiles. In addition, the amount of special equipment required for its production was at a minimum.

To give a better idea of the problem and its successful solution, Fig. 1 shows a steel design of one tube of a tubular type of centrifugal dust collector. The steel tubes used are $6^{5}/_{8}$ in. diam for the main centrifugal tube, and $4^{1}/_{2}$ in. diam for the central or gas-outlet tube. The inlets to the tubes for the gas consist of heavy steel plate welded to an upper and lower disk. Each tube, depending upon the operating conditions, handles in the neighborhood of 250 to 300 cfm of gas, the tubes normally being placed between tube sheets, as shown in Fig. 2. These welded sections, each containing approximately 50 tubes are then joined at their flanges and form the tubular dust collector, as shown in Fig. 3. The gas enters the main section between the two tube sheets, is rotated within the tube after it enters the flared inlets, thus precipitating the dust by centrifugal force, and the clean gas issues through the $4^{1}/_{2}$-in. tube to a point

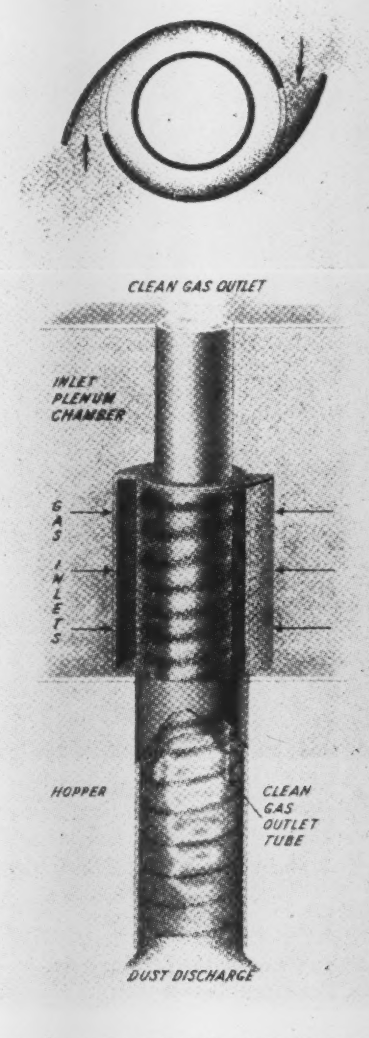

FIG. 1 STEEL TUBULAR DUST COLLECTOR

Contributed by the Materials Handling Division and presented at a meeting of the Metropolitan Section, New York, N. Y., Nov. 15, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

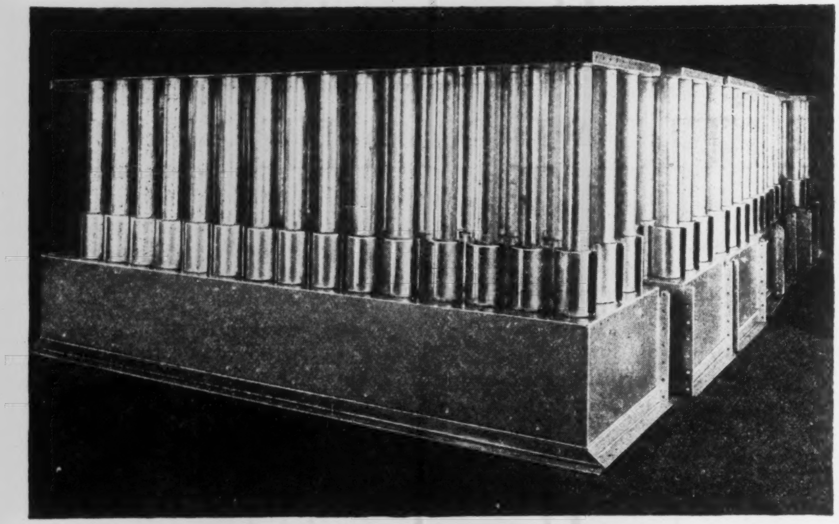

FIG. 2 STEEL TUBULAR DUST COLLECTOR IN SECTIONS

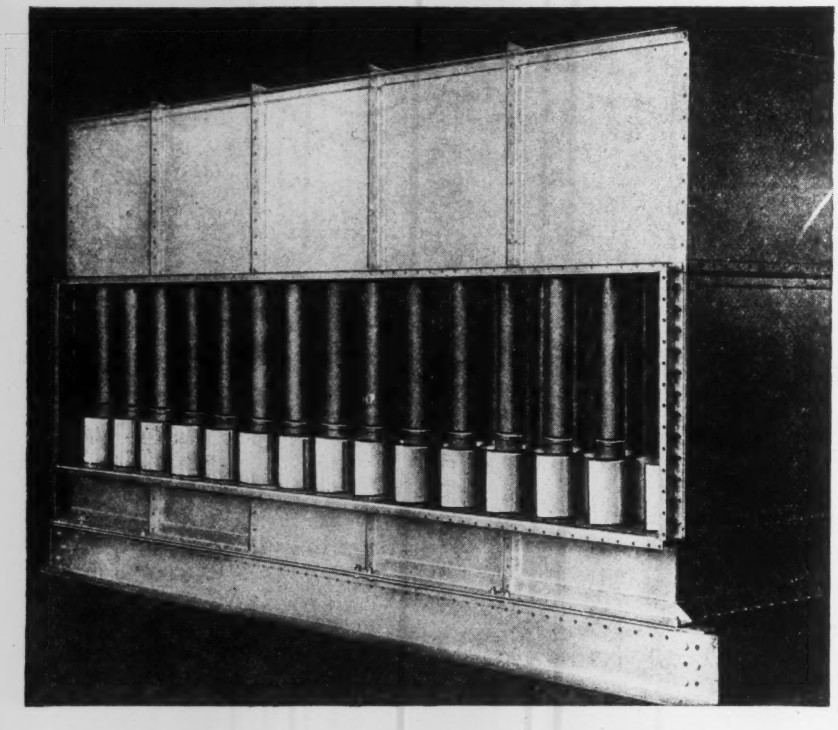

FIG. 3 ASSEMBLED SECTIONS OF STEEL DUST COLLECTOR

above the upper tube sheet, whence it passes to the fan or to the atmosphere.

UTILITY OF CERAMICS AS TUBE MATERIAL

In general accordance with the original directive of the War Production Board, the problem was studied so as to utilize ceramic tubes set in steel tube sheets. A subsequent request on the part of the War Production Board to save in the use of steel, indicated the advisability of using nonpriority material throughout, and, therefore, the final design consisted of: (*a*) fire-clay ceramic tubes; (*b*) reinforced-concrete tube sheets; (*c*) brick side walls, or reinforced-concrete side walls.

Company engineers set up definite specifications to cover a ceramic tube that would meet the following conditions:

1 High dust-collecting efficiency.
2 Ability to resist erosion and corrosion.
3 Qualities to withstand shock of rapid temperature changes.
4 Heat-resisting characteristics to withstand fluctuating temperatures up to, and sustained at or above 600 F.
5 A design that could be manufactured by existing clay-working plants and machinery when supplied with special dies.
6 A design, the component parts of which, may be easily assembled in the field.
7 A type of ceramic tube that would operate equally well in either a steel casing or a nonpriority material housing or casing.
8 A ceramic tube which must meet specifications 1 to 7, inclusive, and be sufficiently rugged and sturdy to withstand the hazard of handling, transportation, and erection, with a minimum of breakage.

A careful study of the properties and characteristics of various fireclays, bonding clays, and other aggregates, was required in order to arrive at a combination which when properly processed would produce ceramic tubes to meet the foregoing specifications. As a result of what proved to be a pioneering effort in this field, a refractory ceramic-tube material was developed which is the basis upon which the author's company designed and produced its ceramic tubular dust collector.

THE CERAMIC TUBE

The lower portion of the tube, shown in Figs. 4 and 4(*a*), consists of a $6^1/_2$-in. tile with a flanged top, in which has been impressed recesses for holding the wings or flared inlets to the tube. These wings consist of a heavy curved tile of special form required for this apparatus. The tile may be made as thick and sturdy as required, since the internal diameter is the important factor. The tube is then capped by a companion flange, identical with the flange on the lower part, containing similar recesses, into which the flared inlet wings are fitted. The central $4^1/_2$-in. tube is similar in shape to standard clay tiles, and this may be extended upward to any required distance by the use of additional tubes.

For field assembly of dust-collecting units, a special cement was developed by the tile manufacturer, composed primarily of the same material from which the tubes are made, which is used to cement the tiles together in a jig. The completed tube assembly is sufficiently strong when removed from the jig, so that it can be handled normally, without danger of any of the cemented joints coming apart.

Tubes are shipped in knocked-down condition, in special crates designed to reduce breakage to a low percentage. The tubes are then set up in the jig at the site of the installation, the parts are cemented together, the jig then being removed. The tube assemblies are allowed to set for 24 hours, after which they can then be handled by workmen without fear of having parts separate. They may be set in either steel tube sheets, to which they are cemented with the same material, or into concrete tube sheets. The $4^1/_2$-in. gas-outlet tube is arranged with a slip joint to allow for expansion.

Engineers of the Robinson Clay Product Co. have made extensive tests in the apparatus, Fig. 4(*b*), to determine the durability of the assembled tube when subjected to heat changes. No damage occurred when the assembled tube was heated to 1600 F with a variation of 200 F per hour. Tests up to 600 F with a 300 F variation per hour also showed no tube fracture.

The specifications for the manufacture of the tube require that it have a coefficient of expansion of approximately 0.000005, and that it be capable of withstanding a temperature range from 0 to 600 F within a period of 2 hr without fracture due to expansion or any other reason.

INVESTIGATION OF CONCRETE AS A TUBE-SHEET MATERIAL

In order to determine the suitability of concrete for tube sheets in temperatures such as are encountered in boiler-plant practice, a careful study was made of past experience in this connection.

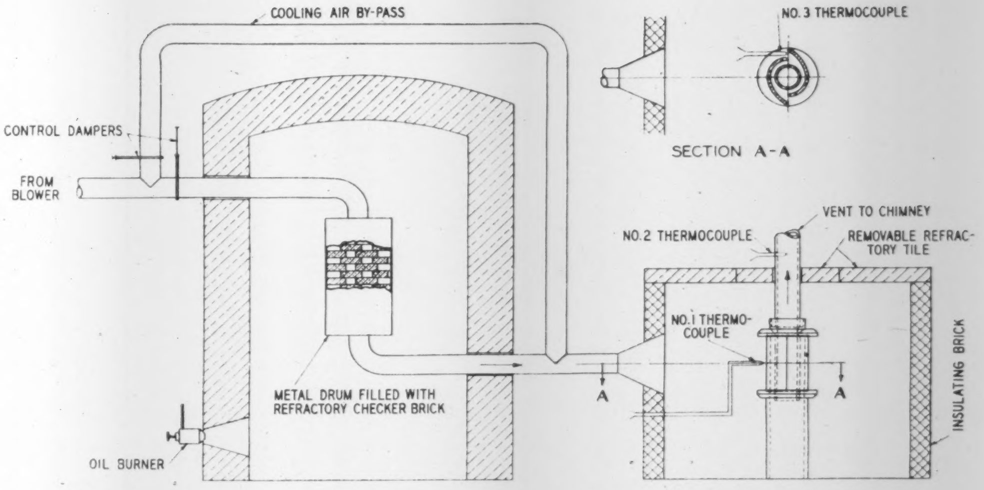
COOLING AIR BY-PASS
CONTROL DAMPERS
FROM BLOWER
METAL DRUM FILLED WITH REFRACTORY CHECKER BRICK
OIL BURNER
NO. 3 THERMOCOUPLE
SECTION A-A
VENT TO CHIMNEY
NO. 2 THERMOCOUPLE
REMOVABLE REFRACTORY TILE
NO. 1 THERMOCOUPLE
A
A
A
INSULATING BRICK

FIG. 4(*b*) HEAT-TEST APPARATUS USED TO DETERMINE EFFECT OF CHANGE OF TEMPERATURE

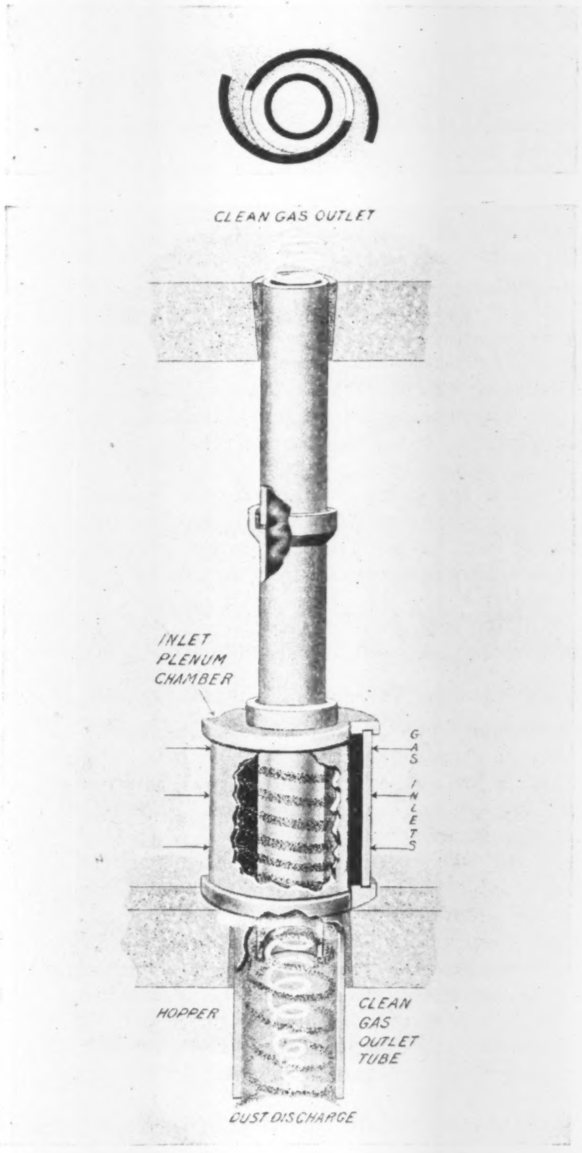
CLEAN GAS OUTLET
INLET PLENUM CHAMBER
GAS INLETS
HOPPER
CLEAN GAS OUTLET TUBE
DUST DISCHARGE

FIG. 4 CERAMIC DUST-COLLECTING TUBE

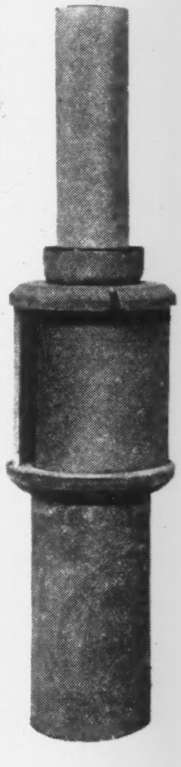

FIG. 4(*a*) PHOTOGRAPH OF COMPLETE CERAMIC TUBE

John L. Graham, Consulting Engineer, who is a specialist in the use of concrete and ceramics, was retained to investigate not only the tube material, but also the use of concrete for the tube sheets. During the first world war, when steel was also considered a critical material, Mr. Graham had designed reinforced-concrete tops and bottoms for boiler flues. His specialty at that time was in connection with wood-product plants burning wood refuse in their boilers.

An installation at Tupper Lake, N. Y., which was equipped with six 400-hp Sterling boilers, had been built with such reinforced-concrete flues in 1916 and 1917. The smoke flue at that plant is 88 ft long, 7 ft wide on the interior, and 12 ft deep. The reinforced-concrete slab floor is 6 in., and the roof is 5 in. thick. Due to the use of wood products, the flue gases reach a temperature of 700 to 750 F. Secondary combustion frequently takes place, thus submitting the concrete to a considerably higher temperature. Furthermore, the boilers are operated up to 200 per cent of rating for a period of 10 hr, and then are banked for a period of 14 hr. This, of course, results in considerable fluctuation in temperature.

This plant has been in continuous operation for approximately 25 years, and Mr. G. P. Hull, the president, states that to date no repairs of any kind have been made on this flue.

The same type of construction has been successfully used in several other plants as follows: At Bay City, Mich., for three large boilers, the flues being 6 ft wide and 30 ft long; a second plant at Tupper Lake, for two 300-hp boilers, with a flue 40 ft long and 5 ft wide; for a plant at Boyne City, Mich., for two 250-hp boilers having a flue 24 ft long and 6 ft wide; and a plant at Saginaw, Mich., for two 300-hp boilers with a flue 20 ft long and 6 ft wide.

After a careful observation of the use of concrete at high temperatures, in these installations, the author's company felt that it was entirely feasible to utilize this type of construction for the tube sheets of a tubular dust collector. It was evident that the dust collector would seldom if ever be subjected to such variations in temperature and such high temperatures as had been observed at the plants mentioned, most having been in operation more than 20 years without any repairs found necessary.

Specifications for the reinforced-concrete tube sheets are extremely strict, and follow closely those used by the consulting engineer in the construction of the concrete tops for the flues previously described. These call for the use of the best grade of American Portland cement, which must be fresh and live, and which has not been exposed to dampness or other conditions which might be injurious to its setting qualities.

The concrete made therefrom must also withstand without cracking, temperature rises from 0 to 600 F over a period of 2 hr. The sand used must be hard, sharp crystal, such as disintegrated or crushed red or black granite. Specifications are given also as to the fineness of the sand, which also must be entirely free of loam, silt organic matter, and particularly from tannic acid.

For the crushed stone or granite used in the mix, only hard granite, hard limestone, dolomite, or traprock may be used. Sandstone is not acceptable. Special instructions are given as to the exact sizing of the crushed stone used in the aggregate. The degree of mixture is likewise important.

Even transportation from the mixer to the job must be done with care, so as to not disturb the homogeneous condition of the concrete mass. Consequently, the use of chutes between the mixers and forms is not acceptable. Prevention from possibility of freezing for a period of at least 21 days must be exercised.

Special designs of reinforcing are used, and the forms must be practically watertight so that there will not be a loss of water in certain portions of the concrete mass.

From the foregoing, it will be realized that this is not an ordinary cement-mixing operation, but one requiring great care and exactitude, which results in a remarkable ability of such cement to withstand high temperatures without damage.

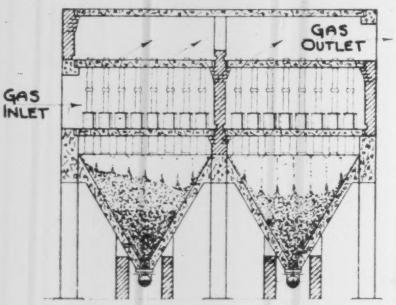

FIG. 5 SINGLE-DECK ARRANGEMENT OF CERAMIC DUST COLLECTOR

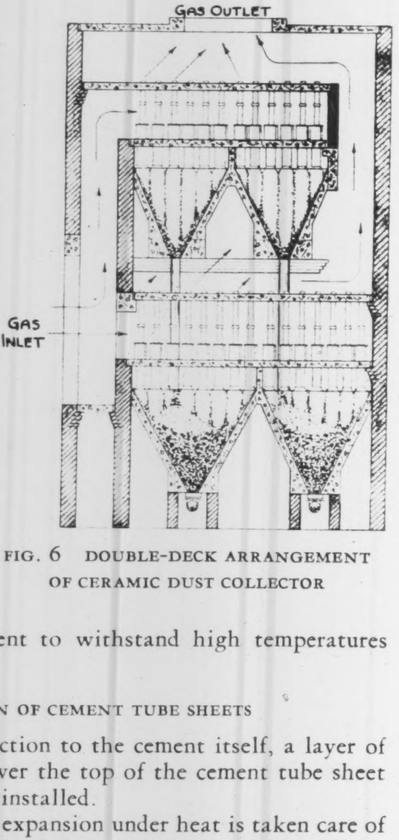

FIG. 6 DOUBLE-DECK ARRANGEMENT OF CERAMIC DUST COLLECTOR

INSTALLATION OF CEMENT TUBE SHEETS

As an additional protection to the cement itself, a layer of fireclay may be flowed over the top of the cement tube sheet after the tubes have been installed.

The question of proper expansion under heat is taken care of by using slabs which are held on corbels, thus permitting the slab to expand without coming in contact with the side walls.

The space required for the ceramic type of dust collector, if arranged in a single deck, is greater than for the steel tubular dust collector. This is due to the fact that the outside dimensions of the tube are greater, to allow for the greater thickness of the ceramic tube, as compared with the steel tube, and the exterior walls are thicker than steel. In other words, the tubes cannot be placed as close together as is possible with steel tubing. This arrangement is shown in Fig. 5. Less area is required if the double-deck arrangement, shown in Fig. 6, is used, although the unit is higher than the single-deck type.

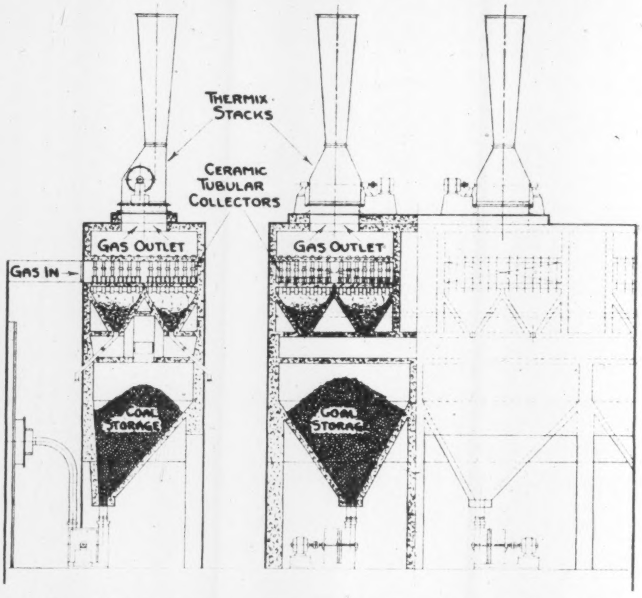

FIG. 7 DUST COLLECTOR DESIGNED AS INTEGRAL PART OF COAL-HOPPER STRUCTURE

The double-deck arrangement, with its greater height, forms convenient support for the induced-draft fan, or the combination fan and stack. Of course the fan can also be placed on top of a single-deck arrangement, but some height of stack is saved by utilizing the double-deck system.

An interesting application is shown in Fig. 7, in which one of the boiler manufacturers designed the structure for the dust collector as part of the structure for the coal hoppers.

The actual weight of each tube, exclusive of the rest of the structure, is approximately the same as the steel tube, since the specific gravity of the fireclay is about one-third of steel. For large installations of dust collectors, it is preferable to utilize this system in a structure from the ground up, either inside the building or outside. If the latter method is used, considerable building space may be saved over that which would have been necessary, even with a steel collector inside of the building.

RELATIVE EFFICIENCIES OF STEEL AND CERAMIC DUST COLLECTORS

This temperature-resisting type of dust collector can be used for removing the dust in connection with power plants before the gas reaches the heat-economy devices, thus preventing collection of dusts on such apparatus, and improving their regular operating efficiency. It is expected that a temperature over 1000 F will offer no difficulty for such installations, but this matter is subject to further study by the research department.

Careful studies have been made of the efficiencies of the ceramic apparatus, as compared to the steel apparatus, and no differences have been indicated, since the dimensional proportions are nearly equivalent. The only part which offers any change in proportion is the thickness of the walls of the internal $4^{1}/_{2}$-in. tube. The exterior ceramic tube has been made slightly larger internally, so that the distance between the outside of the inner tube, and the inside of the outer tube, will be maintained the same as with the steel tube. The increase is so slight, however, that test observations do not indicate any noticeable difference in efficiency due to the larger diameter.

Special attention should be drawn to the fact that in many industrial installations, corrosion of steel is a serious problem, hence, the inactive nature of the ceramic material in the construction of these tubes is a considerable advantage in such cases.

PRACTICAL CUTTING-FLUID RECOMMENDATIONS

For Use With High-Speed-Steel Tools

By O. W. BOSTON,[1] H. L. MOIR,[2] E. M. SLAUGHTER,[3] AND W. H. OLDACRE[4]

THE object of this paper is to present cutting-fluid recommendations for various machining operations used in commercial practice. Each recommendation must consider several factors, principal ones of which are:

(*a*) The material cut—its analysis, treatment, machinability, etc., summarized here as "class;"

(*b*) The machining operation (this involves high, low, and intermediate speeds, various sizes and shapes of cuts, various purposes such as long tool life, superior finish, chip form and size, and the availability of the cutting fluid).

These are summarized under the heading of "type and severity of operation."

METALS RATED

To simplify and to make more clear the use of a table of recommendations which can be used to apply cutting fluids to various processes, involving different metals, the metals themselves are first listed in classes in accordance with their machinability ratings. A wide variety of ferrous and nonferrous metals are rated individually and then arranged in the six classes of Table 1.

The machinability rating of each metal of the several groups has been given values to the nearest 5 per cent. The various metals have then been grouped into classes as shown in Table 2 to facilitate the drawing up of the cutting-fluid chart. The ratings are based on steels in a cold-drawn condition unless otherwise stated. Metals that have been heat-treated or processed in any way other than cold-drawn will, of course, have different machinability ratings.

It is important to note that because of the favorable price differential many users prefer hot-rolled steels for many purposes. The relative effect of hot-rolling may be expressed very briefly as follows:

(*a*) In steels containing up to 0.30 per cent carbon, cold-rolled bars have better machinability than hot-rolled bars.

(*b*) In steels containing from 0.30 per cent to 0.40 per cent carbon, there is little difference in machinability between cold-rolled and hot-rolled bars.

(*c*) In steels containing over 0.40 per cent carbon, the hot-rolled material has superior machinability over the cold-rolled or cold-drawn. It is recommended that the carbon steels having 0.40 per cent carbon or more and alloy steels having 0.30 per cent carbon or more be annealed for machining, otherwise lower cutting speeds are necessary. This also applies to paragraph (*b*).

The range of Brinell hardness values for each of the ferrous materials is intended to provide the most desirable limits for normal machinability ratings and, in general, describes the commercial practice in filling steel-purchase orders. It is generally accepted practice that the limiting value of hardness for normal machinability is of the order of 355 Brinell although many steels are now being machined in mass production at hardnesses of 400 Brinell and higher.

TABLE 1 THE SIX CLASSES OF METALS FOR WHICH CUTTING FLUIDS ARE RECOMMENDED

Ferrous metals as compared with A.I.S.I. B-1112 cold-drawn steel

Class 1—70 per cent or over
Class 2—50 per cent to 65 per cent
Class 3—40 per cent to 50 per cent
Class 4—below 40 per cent

Nonferrous metals as compared with A.I.S.I. B-1112 cold-drawn steel

Class 5—100 per cent or over
Class 6—below 100 per cent

Factors influencing machinability are many. The ratings by tests often show greater variation because of different heats than because of a wide range in analysis. Like steels from different manufacturers may vary in machinability over a wide range. The relative rating of several materials when cut under one size and shape of cut with one type of cutting fluid may be quite different if another cut, tool shape, tool material, or cutting fluid is used. The different processes, such as drilling, turning, and milling will yield different orders of ratings for a group of metals. Surface conditions such as scale and cold-working hardness may also vary the results. With the lack of specific conditions of almost every variable, it is felt that these ratings are close enough to permit the production man to set up each job to work and then, from observation, modify the setup to get best results.

MACHINING OPERATIONS CLASSIFIED

A similar classification has been given to machining operations, arranging them in order of their severity, for example: The most severe operation, No. 1, Table 3, is internal broaching, and the easiest, No. 10, is sawing.

RECOMMENDATIONS

Table 3 indicates the severity of the operation and recommends the cutting fluid for each class of metal. The attention of users of this table is called to the following general note on cutting-fluid selection:

1 The preferred recommendations underlined in Table 3 are based on general practice observed by the authors and from reports from a survey conducted by the members. The recommendations are intended to serve only as a guide to the choice of a cutting fluid. It must be remembered, however, that a cutting-fluid selection should be based on the individual operation, the material being machined, the tool, its material, size, and shape, and the conditions of operation, such as speed,

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This report is submitted by the Subcommittee on Cutting Fluid Recommendations of the Independent Research Committee, the chairman of which is Joseph Geschelin. Other members of the committee are M. A. Dixon, O. W. Boston, H. M. Fearon, Floyd Fritts, C. B. Harding, Raymond Haskell, W. D. Huffman, J. F. Kennedy, W. H. Kildow, H. E. Martin, B. B. Mears, R. J. McWilliams, H. L. Moir, W. H. Oldacre, E. M. Slaughter, and G. L. Summer.

TABLE 2 MACHINABILITY RATING OF FERROUS METALS OF FOUR CLASS GROUPS AND NONFERROUS METALS OF TWO CLASS GROUPS

(Each metal is rated to the nearest 5 per cent based on the 100 per cent rating of A.I.S.I. steel specification B 1112, cold-rolled or cold-drawn, when machined with a suitable cutting fluid at 180 feet per minute under normal cutting conditions.)

Prefix-Letter Designations

C—Basic open-hearth carbon steel
B—Acid Bessemer carbon steel
CB—Either acid Bessemer or basic open-hearth carbon steel at the option of the manufacturer
A—Basic open-hearth alloy steels
E—Electric-furnace steels of both carbon and alloy types
NE—National-Emergency series steels

Class 1—Ferrous (70 per cent and higher)

A.I.S.I.	Rating, per cent	Brinell
C 1110	85	137–166
C 1115	85	143–179
C 1117	85	143–179
C 1118	80	143–179
C 1120	80	143–179
C 1132	75	187–229
C 1137	70	187–229
C 1022	70	159–192
C 1016	70	137–174
B 1111	95	179–229
B1112	**100**	**179-229**
B 1113	135	179–229
A 4023	70	156–207
A 4027*	70	166–212
A 4119	70	170–217
Malleable iron		
(Ferritic)	100–250	120–200
(Pearlitic)	70	190–240
Cast steel		
(0.35% C)	70	170–212
Stainless iron		
(Free-cutting)	70	163–207

Class 2—Ferrous (50 to 65 per cent)

A.I.S.I.	Rating, per cent	Brinell
C 1141	65	183–241
C 1020	65	137–174
C 1030	65	170–212
C 1035	65	174–217
C 1040*	60	179–229
C 1045*	60	179–229
NE 1330*	65	179–235
NE 1340*	60	187–241
NE 1350*	55	187–241
A 2317	55	174–217
A 3045*	60	179–229
A 3120	60	163–207
A 3130*	55	179–217
A 3140*	55	187–229
A 3145*	50	187–235
A 4032*	65	170–229
A 4037*	65	179–229
A 4042*	60	183–235
A 4047*	55	183–235
A 4130*	65	187–229
A 4137*	60	187–229
A 4145*	55	187–229
A 4150*	50	187–235
A 4615	65	174–217
A 4640*	55	187–235
A 4815	50	187–229
A 5120	65	170–212
A 5140*	60	174–229
A 5150*	55	179–235
A 5045*	65	179–229
NE 8024 (*a*)	60	174–217
NE 8124 (*a*)	55	174–217
NE 8233 (*a*)	60	179–229
NE 8339* (*a*)	60	179–229
NE 8620	60	170–217
NE 8630*	65	179–229
NE 8720	65	179–229
NE 8739* (*a*)	60	179–229
NE 8744* (*a*)	55	183–235
NE 8749* (*a*)	50	183–241
NE 8817 (*a*)	60	170–228
NE 9415	55	170–217
NE 9425 (*b*)	50	170–217
NE 9430*	65	179–228
NE 9440*	60	187–235
NE 9450*	45	187–235

(*a*) Discontinued.
(*b*) New steel, rating estimated.

Class 3—Ferrous (40 per cent to 50 per cent)

A.I.S.I.	Rating, per cent	Brinell
C 1008	50	126–163
C 1010	50	131–170
C 1015	50	131–170
C 1050*	50	179–229
C 1070*	45	183–241
A 1320	50	170–229
A 1330*	50	179–235
A 1335*	50	179–235
A 1340*	45	179–235
A 2330*	50	179–229
A 2340*	45	170–235
A 3240*	45	183–235
A 4340*	45	187–241
A 6120	50	179–217
A 6145*	50	179–235
A 6152*	45	183–241
NE 9250*	50	179–217
NE 9260*	45	187–255
NE 9261* (*b*)	50	179–217
NE 9262*	45	187–241
NE 8442* (*a*)	45	187–255
NE 8447* (*a*)	40	187–255
NE 8949* (*a*)	50	187–255
Ingot iron	50	101–131
Wrought iron	50	101–131
Stainless 18–8 F.M.	45	179–212
Cast iron	50	160–193

(*Table 2 continued on following page*)

depth of cut and feed, and the results desired in tool life, chip formation, and finish.

2 It is important to keep in mind that the function of this report is to correlate recommendations from general use and practice, together with suggestions for each specific cutting problem. These recommendations represent the average practice of the majority of users of cutting fluids when normal operating conditions are maintained.

3 It is possible to determine the proper cutting fluid for these normal operating conditions by referring to the table: For example, a normal milling operation, where the operating condition is within the limits specified by the manufacturer of the machine, and the steel of one class as given in the table. However, if a deeper cut, higher cutting speed, heavier feed, etc., are desired, it will become necessary for the user to be guided by the table in placing the operation in the proper severity classification, indicating the cutting oils recommended for the more severe operation.

4 The cutting-fluid recommendations of Table 3 must of necessity be confined to types of fluids rather than the products of individual companies. This should be remembered in the purchase of such fluids as there may be quite a difference in effectiveness between two fluids of the same type on a given machining operation owing to different manufacturing techniques of the producers.

5 It is possible to break this classification down considerably further and perhaps make it more specific. However, such a breakdown of operations with the various cutting fluids, etc., together with feeds, cutting speed, depth of cut, and the like makes the analysis bulky and unwieldy. In many

TABLE 2 (*Continued from preceding page*)

Class 4—Ferrous (40 per cent and below)

A.I.S.I.	Rating, per cent	Brinell	A.I.S.I.	Rating, per cent	Brinell
A 2515*	30	170–229	Manganese oil-hardening steel**	30	... ...
E 3310*	40	170–229	Tool steel, low-tungsten chromium, and carbon**	30	... ...
E 52100**	30	183–229	High-speed steel**	30	200–218
Ni-Resist*	30	... ...	High-carbon, high-chrome tool steel**	25	... ...
Stainless 18–8 (Austenitic)*	25	150–160			

Class 5—Nonferrous (above 100 per cent)

Metals	Rating, per cent	Brinell	Metals	Rating, per cent	Brinell
Magnesium alloys			Aluminum (*continued*)		
Dow "J" (wrought) 92.3 Mg, 6.5 Al, 0.2 Mn, 1 Zn	500–2000	58	17S-T (4 Cu, 0.5 Mn, 0.5 Mg, 95 Al)	300–1500	100 (500 kg)
Dow "H" (cast) 90.8 Mg, 6 Al, 0.2 Mn, 3 Zn	500–2000	50	Brass, leaded F.C., C.D. (62 Cu, 35 Zn, 3 Pb)	200–400	50 (500 kg)
Aluminum			Red, leaded (78.5 Cu, 20 Zn, 1.5 Pb)	180	55 (500 kg)
11S-T3 (5.5 Cu, 0.5 Pb, 0.5 Bi, 93.5 Al)	500–2000	95 (500 kg)	Bronze, phos., leaded (94 Cu, 1 Pb, 5 Sn)	100	75 (500 kg)
2S (100 Al) O to H temper	300–1500	23–44 (500 kg)	Zinc	200	

Class 6—Nonferrous (below 100 per cent)

Metals	Rating, per cent	Brinell	Metals	Rating, per cent	Brinell
Aluminum bronze (cast) 89.7 Cu, 10 Al, 0:2 Fe, 0.5 Sn	60	140–160	Monel metal,* regular (68 Ni, 29 Cu, +)	40	125–150
Brass			As cast, "H" (65 Ni, 29 Cu, 2 Fe, 2.75 Si, 0.2 C, 0.7 Mn)	35	175–250
Yellow (63 Cu, 37 Zn)	80	50–70 (500 kg)	As cast, "S" (64 Ni, 29 Cu, 2.5 Fe, 3.75 Si, 0.1 C, 0.5 Mn)	20	280–325
Red (80 Cu, 20 Zn)	60	55 (500 kg)	Rolled (67 Ni, 31 Cu, 1.16 Fe, 0.7 Si, 0.1 C, 0.8 Mn)	45	207–224
Bronze, mang. (59 Cu, 39 Zn, 0.7 Sn, 0.5 Mn, 0.8 Fe)	60	80–95 (500 kg)	"K" (66 Ni, 29 Cu, 0.9 Fe, 0.5 Si, 0.15 C, 2.75 Al)	50	215–265
Bronze, phos. (95 Cu, 5 Sn)	40	140	Inconel, temper B, cold-drawn* (78 Ni, 14 Cr, 6 Fe)	45	130–170
Copper, cast	70	30			
Copper, rolled (1/4 hard)	60	80			
Everdur (Cu-Si) 95.80 Cu, 1.10 Mn, 3.10 Si	60	200			
Everdur (Cu-Si) 95.60 Cu, 1.0 Mn, 3.0 Si, 0.4 Pb	120	200			
Gun metal (cast) 88 Cu, 10 Sn, 2 Zn	60	65			
Nickel (hot-rolled)	20	110–150			
Nickel (cold-drawn)*	30	100–140			

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* Annealed.

** Spheroidized anneal.

NOTE: The term "annealed" and "spheroidized anneal" refer specifically to the commercial practice in steel mills, prior to cold-drawing or cold-rolling, in the production of the steels specifically mentioned.

TABLE 3 CUTTING-FLUID RECOMMENDATIONS FOR VARIOUS MACHINING OPERATIONS FOR EACH OF SIX GROUPS OF METALS BASED UPON NORMAL OPERATING SPEEDS, TOOL LIFE, AND FINISH

		Groups of metals based on class of machinability ratings					
Severity	Type of operation	1 Ferrous, over 70%	2 Ferrous, 50–65%	3 Ferrous, 40–50%	4 Ferrous, below 40%	5 Nonferrous, over 100%	6 Nonferrous, below 100%
1 (Greatest)	Broaching, internal	Em. Sulph. (*a*)	*Sulph.* (*b*) Em.	*Sulph.* Em.	*Sulph.* Em.	Mo. Em.	Sulph. ML.
2	Broaching, surface	Em. Sulph.	*Em.* Sulph.	*Sulph.* Em.	*Sulph.* Em.	Mo. Em.	Sulph. ML.
3	Tapping, plain	Sulph.	Sulph.	Sulph.	Sulph.	Em. Dry	Sulph. ML.
2	Threading, pipe	Sulph.	*Sulph.* ML.	Sulph.	Sulph.		Sulph. (*c*)
3	Threading, plain	Sulph.	Sulph.	Sulph.	Sulph.	Em. Sulph.	Sulph.
4	Gear shaving	Sulph. L.	Sulph. L.	Sulph. L.	Sulph. L.		
4	Reaming, plain	ML. Sulph.	ML. Sulph.	ML. Sulph.	ML. Sulph.	ML. Mo. Em.	ML. MO. Sulph.
4	Gear cutting (*d*)	Sulph. ML. Em.	Sulph.	Sulph.	Sulph. ML.		Sulph. ML.
5	Drilling, deep	*Em.* ML.	Sulph. *Em.*	Sulph.	Sulph.	Mo. ML. Em.	Sulph. ML.
6	Milling, plain	*Em.* ML. Sulph.	Em.	Em.	Sulph.	Em. Mo. Dry	Sulph. Em.
6	Milling, multiple-cutter	ML.	Sulph.	Sulph.	*Sulph.* ML.	Em. Mo. Dry	*Sulph.* Em.
7	Boring, multiple-head	*Sulph.* Em.	*Sulph.* Em.	*Sulph.* Em.	Sulph. Em.	K. Dry Em.	Sulph. Em.
7	Multiple spindle automatic screw	Sulph. Em. ML.	Sulph. Em. ML.	Sulph. Em. ML.	Sulph. ML. Em.	Em. Dry ML.	Sulph.
8	High-speed, light-feed automatic screw machines	Sulph. Em. ML.	Sulph. Em. ML.	Sulph. Em. ML.	Sulph. ML. Em.	Em. Dry ML.	Sulph.
9	Drilling	Em.	Em.	Em.	Em. Sulph.	Em. Dry	Em.
9	Planing, shaping	*Em.* Sulph. ML.	*Em.* Sulph. ML.	Sulph. *Em.*	*Em.* Sulph.	Em. Dry	Em.
9	Turning, single-point tool, form tools	Em. Sulph. ML.	Em. Sulph. ML.	Em. Sulph. ML.	Em. Sulph. ML.	Em. Dry ML.	Em. Sulph.
10 (Least)	Sawing, circular, hack	Sulph. ML. Em.	Sulph. Em. ML.	Sulph. Em. ML.	Sulph. Em. ML.	Dry Mo. Em.	Sulph. Em. ML.
	Grinding						
	(*a*) Plain	Em.	Em.	Em.	Em.	Em.	Em.
	(*b*) Form (thread, etc.)	Sulph.	Sulph.	Sulph.	Sulph.	Mo. Sulph.	Sulph.

Symbols for cutting fluids: K—Kerosene; L—Lard oil; Mo—Mineral oils; ML—Mineral-lard oils; Dry—no cutting fluid; Sulph.—Sulphurized oils (see note "*a*"); Em—Soluble or emulsifiable oils and compounds.

NOTES: (*a*) Oils containing both sulphur and chlorine when carefully manufactured and sponsored may be used where sulphurized oils are indicated.

(*b*) Preferred recommendations are in italics. (*c*) In threading copper, palm oil is frequently used.

(*d*) It has been reported by several observers that emulsions are usually unsatisfactory on some precision machine tools such as Fellows gear shapers and Gleason gear generators.

instances such a list of recommendations would be difficult for the lay user of cutting oils to interpret.

6 Generally speaking, mineral-lard oil and sulphurized-oil mixtures of low sulphur percentages are interchangeable.

7 Sulphurized oils have a tendency to stain certain nonferrous metals, such as copper and its alloys.

8 Certain materials such as carbon tetrachloride, chloroform, and other volatile solvents should not be added to cutting fluids, as harmful physiological effects might follow.

9 In the machining of aluminum, cutting oils are many times diluted with kerosene or mineral seal oil with satisfactory results. Kerosene, up to 15 per cent, is frequently added to emulsions to improve the surface quality of machined aluminum.

10 Magnesium and its alloys are usually machined with mineral seal oil except where it is desirable to machine-dry. A supply of powdered asbestos or graphite should be kept handy to smother a fire, just in case. A powder extinguisher known as G-1 powder is marketed by the Pyrene Company; it was developed jointly by the Pyrene Company and the Dow Chemical Company. Tools should be kept sharp and heavy feed should be used. Chips should not be permitted to accumulate on the machine.

11 In machining brass, which shows no change in cutting pressures with various cutting fluids, it is advisable to apply a cutting fluid to function as a coolant. Inasmuch as most free-cutting brass is machined in automatic screw machines, an oil is advisable to lubricate the moving parts of the machine. A paraffin or light mineral oil may suffice, or the mineral oil blended with 10 per cent fatty oil may be used to advantage.

12 In turning Monel metal, it has been found that an emulsion gives a slightly longer tool life than a sulphurized mineral oil. However, the latter produces broken up chips which in many instances is desirable.

13 In general, cutting fluids should be applied in large quantities at the highest velocity possible without splashing, directly onto the tool point where the chip is being formed. From three to five gallons for each single-point tool is most effective. Particularly when carbide tools are used the cutting fluid should flood the tool before the start of the cut and be applied continuously during the cut. Rapid change in temperature is injurious to most tools.

14 Keep cutting fluids cool, either through the use of sufficient volume or through the use of cooling agencies. For satisfactory tool life, temperature of the cutting fluid should not be permitted to exceed 110 F.

15 Keep cutting fluids clean—free from suspended chips, bacteria, and high acidity.

16 On complicated machines, oils should be used where parts, such as tool slides, must be lubricated. On some jobs, such as milling and drilling, lubrication of the chips in the flutes or chip space is an important factor in chip removal.

17 On high-speed operations, cooling is more important than lubrication, inasmuch as the speed itself usually provides good surface quality. On low speeds where the segmental or discontinuous type of chip is formed, the face of the tool may be periodically lubricated so that oils, and particularly a hurized supoil for threading and broaching, are desirable.

Fuels and Fuel Research in Great Britain During the War

(*Continued from page 884*)

installation. The construction of the converters alone presented a difficult engineering problem because they operate around 4000 psi while they are exposed to the action of hydrogen gas and certain corrosive conditions existing in the oil-coal mixtures. British practice has been to make forgings of the desired size and carry the liquid in a separate container in the inside. This container is made of alloy steel to withstand the corrosive conditions, but it does not carry the pressure. Closures for the converters, all valves, pipe fittings, heat exchangers, compressors, and paste-handling equipment presented special engineering problems that were met and conquered. The complete converter weighs almost 60 or 70 tons, and a special crane was erected as part of the plant to facilitate repair work on these units.

Control of the high pressures, liquid levels, flow rates, and temperature necessitated the development of a large variety of special gages, measuring, and controlling equipment. The problems have now been solved so successfully that plant operation is virtually automatic. Relatively few men are needed in the control room and their duty is to see that the controls are functioning properly.

In spite of the success with which this plant operated, there was no further commercial development of coal hydrogenation in Great Britain, apparently because it was cheaper to import gasoline and oil instead of making it from coal. The war has greatly altered this viewpoint, for the British now realize that their water-borne shipments may be cut off and leave their air, ground, and naval forces in a precarious position.

The Bergius coal-hydrogenation method is not the only one available for converting coal to liquid fuel. The Fischer-Tropsch process, also developed in Germany, can be used. Here the coal or other fuel is first converted into carbon monoxide and hydrogen; these gases are passed over a catalyst, usually cobalt and thorium oxide on kieselguhr, at a carefully controlled temperature to obtain waxes, oil, gasoline, and hydrocarbon gases. The gasoline is of comparatively low octane value, but the oil is an excellent Diesel fuel and can be converted to a satisfactory lubricating oil.

The Fischer-Tropsch plants in Germany are producing about one-fifth as much oil and gasoline as the Bergius plants. In Great Britain, however, there has been no commercial development of the Fischer-Tropsch process. The Fuel Research Station is engaged in extensive laboratory work and has made some very valuable discoveries concerning the catalysts, methods of preparation, conditions of operation, and in the preparation of lubricants. Their work will form an excellent basis for future commercial developments in Great Britain.

Governmental and scientific circles in Great Britain are now fully awakened to the importance of these processes for making liquid fuels from coal. Strong pressure is arising to force increased activity with respect to the Fischer-Tropsch process, even before the war is over. They are looking at the methods, and particularly the Fischer-Tropsch, not only with respect to liquid fuels but also as a source of raw material for synthetic rubber, plastics, explosives, and chemicals. It is to be hoped that this same realization of the potentialities inherent in these developments will arise in the United States.

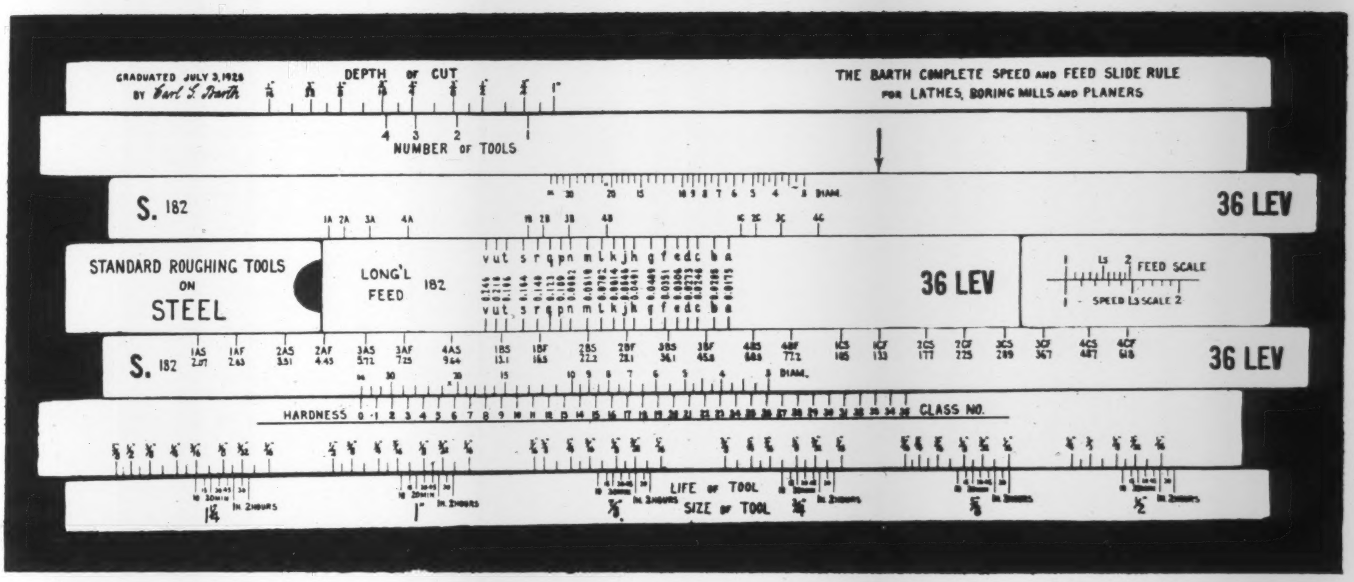
GRADUATED JULY 3, 1928 BY Carl G. Barth
DEPTH OF CUT
THE BARTH COMPLETE SPEED AND FEED SLIDE RULE FOR LATHES, BORING MILLS AND PLANERS
NUMBER OF TOOLS
S. 182
36 LEV
STANDARD ROUGHING TOOLS ON STEEL
LONG'L FEED
FEED SCALE
SPEED LS SCALE 2
DIAM.
HARDNESS
CLASS NO.
LIFE OF TOOL
SIZE OF TOOL
IN 2 HOURS

FIG. 1 THE BARTH SLIDE RULE

(The upper half of the rule concerns power and considers the effects of the variables depth of cut, number, of tools, diameter of work, rpm, and feed, while the lower half of the rule concerns tool life and considers the effects of the variables feed, rpm, diameter of work, hardness of work, depth of cut, size of tool, and tool life.)

METAL-CUTTING NOMOGRAPH

For Cutting Steel With Single-Point Tools

By W. W. GILBERT and W. C. TRUCKENMILLER

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THE metal-cutting nomographs presented in this paper are a simplified summary of some of the more important variables in the machining of steel. A great number of tables of machinability ratings, including recommended speeds, feeds, depths of cut, and motor-power requirements, have been published in the last several years, but their lack of correlation and accessibility have been serious drawbacks for their practical application.

When attempting to obtain higher production, usually one is limited by either poor tool life or insufficient power. To obtain the maximum rate of metal removal, it is necessary to balance the horsepower and the tool life. Originally, this method was used by Taylor and Barth when they constructed slide rules (1)[1] which would show the maximum rate of metal removal for lathes, boring mills, or planers. The basic idea of this slide rule has been preserved and is used in the nomograph presented in this paper, but it has been revised to include modern materials and it can be used on geared-head motor-driven equipment, as well as the old type of belt-drive machine tool.

The nomographs make available some of the more important laws in metal cutting which show (1) the tool life, (2) the power required, and (3) a combined nomograph which shows the maximum output available from a given machine. No attempt has been made to correlate surface finish with the other variables.

The variables of machinability which were included in these nomographs are as follows:

V = cutting speed, fpm
T = tool life, min
K_{tm} = constant for tool life, depending upon tool material
K_{mc} = constant for tool life, depending upon material cut
f = feed, inches per revolution
d = depth of cut in inches
C_{Bhn} = a constant for tool force, depending upon Brinell hardness of material cut

TOOL LIFE

The variables which were considered to have the most important effect upon tool life were:

Cutting Speed. Typical tool-life cutting-speed curves are shown in Fig. 2 for different types of tool materials. These test data may be expressed as an equation of the form $VT^n = C$. An average value of the slope of these curves is 0.125. Light cuts or nonabrasive material will give a flatter slope, that is, a smaller value for n. Heavy cuts or more abrasive material will give a steeper slope.

Tool Material. The main types of tool materials are carbon tool steel, high-speed steel, cast cobalt-chromium-tungsten alloys, and the cemented carbides. Typical tool-life curves are shown for these materials in Fig. 2. These ratings may be changed considerably if vibration or chatter occurs, or if incorrect tool design is used.

Material Cut. By running tool life-cutting speed tests for several materials, the cutting speed V_{90} may be obtained for a 90-min tool life. In Fig. 3 are shown the values of V_{90} as plotted against Brinell hardness numbers for several typical steels. The cutting speed may be more accurately predicted if, in addition to the Brinell hardness, the reduction of area is also considered. E. J. Janitzky (7) has shown this relation to be

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[1] Numbers in parentheses refer to list of references at end of paper.

Contributed by the Special Research Committee on Cutting of Metals for presentation at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

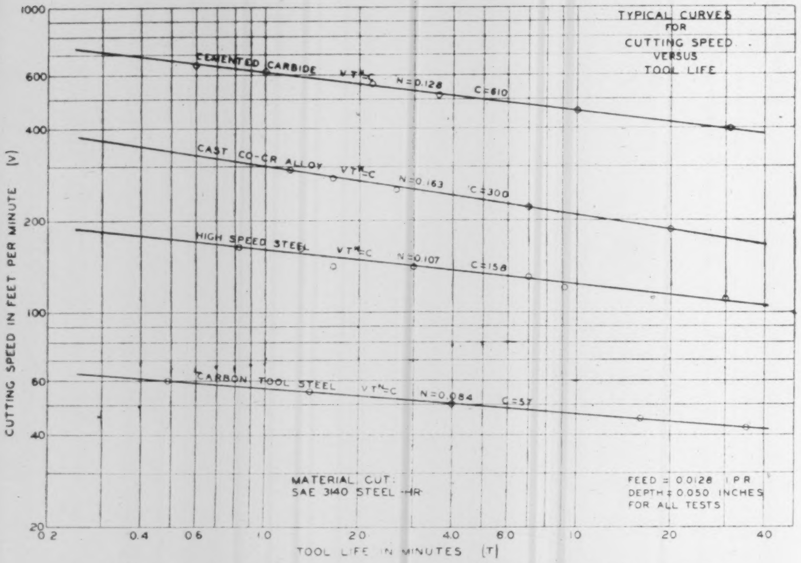


FIG. 2 TYPICAL CURVES FOR CUTTING SPEED VERSUS TOOL LIFE

$V_{60} = \dfrac{C}{B^{1.63}R^{1.01}}$ where B is the Brinell hardness number and R is per cent reduction of area.

Size of cut. The feed and depth have a considerable influence upon the allowable cutting speed or tool life. In Fig. 4 are shown typical curves giving the relationship between V_{90} and the feed and depth. The data represented in Fig. 4 were originally presented by Taylor. These data may be put into the equation $V_{90}f^{0.61}d^{0.36} = K$, which shows that as the feed and depth are increased, the cutting speed must be decreased to keep the tool life constant. These data also show that it is extremely important to increase the depth, if possible, as the exponent of d is 0.36, meaning that if the depth of cut were doubled, the cutting speed would have to be reduced 22 per cent, with a net increase of 56 per cent in metal removal. It is also important to use heavy feeds, as the exponent of feed is 0.61. If the feed were double, it would be necessary to decrease the velocity by only 34 per cent, and the rate of metal removal increases 31 per cent.

Tool Shape. All of the data in the tool-life nomograph was corrected to a tool shape having 8 deg back rake, 14 deg side rake, 6 deg end relief, 6 deg side relief, 6 deg end-cutting-edge angle, 15 deg side-cutting-edge angle, and $^3/_{64}$ in. nose radius. If the nose radius or side-cutting-edge angle were increased, the thinner chip and longer length of cutting edge produce longer life or allow up to 50 per cent higher cutting speeds to be used. This may not be true on cemented-carbide tools because of the extreme abrasion and possible chatter on large-nose-radius tools. The correct rake angle will depend upon the material cut. An angle of 20 to 30 deg should be used for the softer more ductile steels, whereas for hard and brittle steels, rake angles of 0 to 10 deg should be used.

Cutting Fluids. The tool-life nomograph was designed for dry cutting, but since cutting fluids are used in most cases, the values given on the nomograph will be conservative. Emulsions are used where high cutting speeds and cooling are important, and an increase of 15 to 30 per cent in cutting speed can be expected. If cutting oils are used, where longer tool life is important, the cutting speed may be increased from 10 to 25 per cent.

Tool-Life Nomograph. The effect of each of these variables may be combined into a single equation $VT^{0.125} = \dfrac{K_{tm}K_{mc}}{f^{0.61}d^{0.36}}$. This equation is the basis for the construction of the tool-life nomograph shown in Fig. 5. All of the scales are logarithmic and are of sufficient range for most practical applications. If any of the five variables of the nomograph are known, the sixth may easily be found. An example of a tool-life problem is given at the bottom of Fig. 5 where the tool material was high-speed steel, the material cut was an S.A.E. 1020 steel having a Brinell hardness number of 160, the desired tool life was 60 min, the depth of cut was 0.0625 in., and the feed was 0.0625 in. per revolution. The resulting velocity which could be used for these conditions was 60.5 fpm. The two variables most easily changed for a given machine setup are the feed and the speed. The nomograph is so constructed that by pivoting a line around a point on the scale C, the effect of varying the feed will be indicated by a change of velocity. If the feed in the sample calculation of Fig. 5 were reduced to one quarter of its original value, or 0.0155 in. per revolution, the cutting speed could be increased from 60.5 fpm to 142 fpm. This would give a *decrease* in production of 42 per cent by using the lighter feed and the higher speed.

POWER

Some of the more important variables which must be considered when measuring power are: The motor power available, the machine efficiency, the material cut, and the depth of cut, the feed, and the cutting speed. The horsepower required by the motor is

$$\text{Horsepower} \times \text{efficiency} = \frac{\text{Force} \times \text{velocity}}{33{,}000}$$

where force is in pounds and velocity is in feet per minute

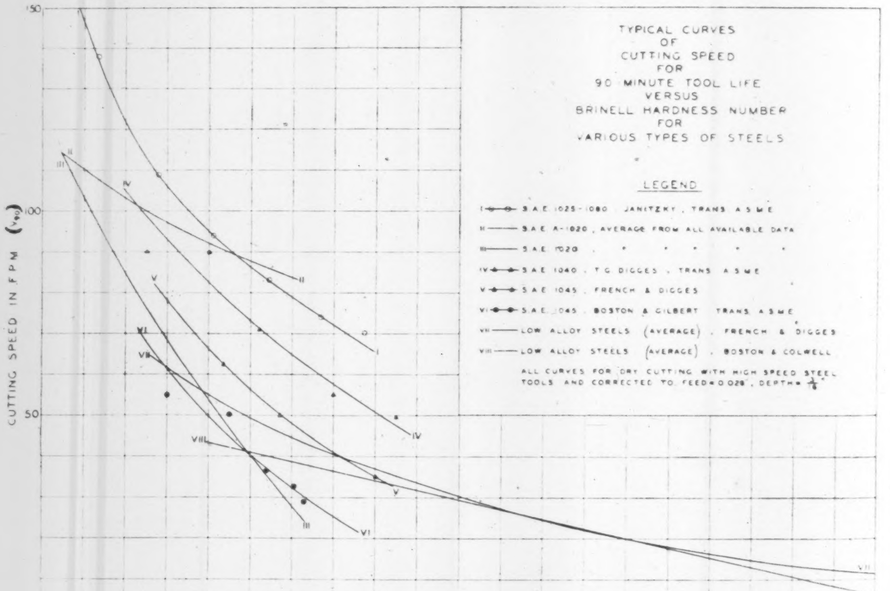


FIG. 3 TYPICAL CURVES OF CUTTING SPEED FOR 90-MIN TOOL LIFE VERSUS BRINELL HARDNESS NUMBER FOR VARIOUS TYPES OF STEELS

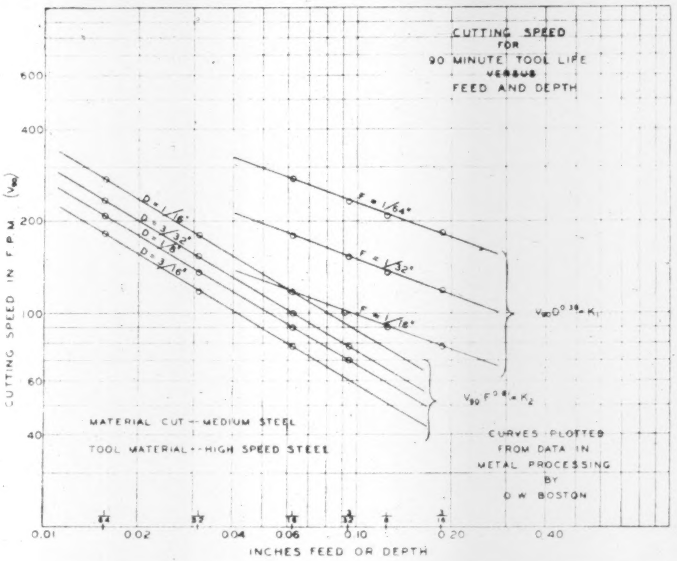


FIG. 4 CUTTING SPEED FOR 90-MIN TOOL LIFE VERSUS FEED AND DEPTH

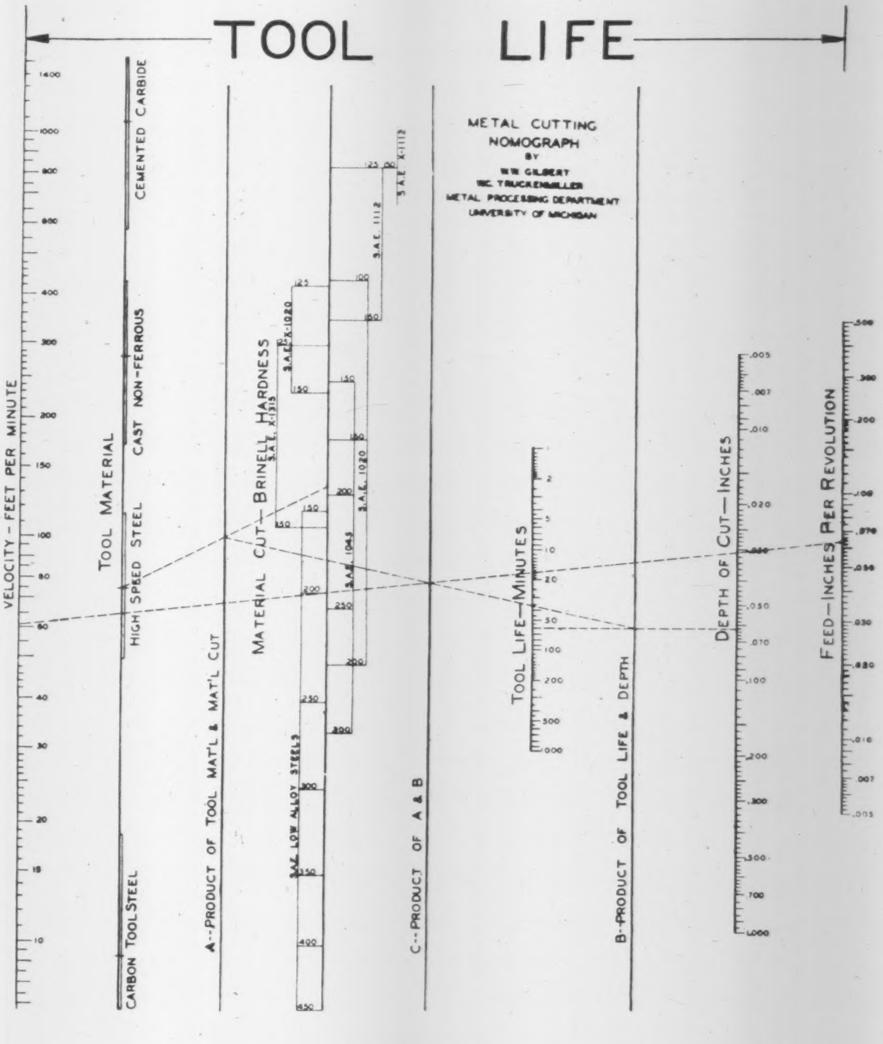
This equation is true only if the tangential force on the tool is not affected by a change in cutting speed.

Cutting Speed. Tests were made to determine the effect of the cutting speed upon the tool forces. A dynamometer was used to measure the tangential tool force and these results were checked by taking horsepower readings on the motor and converting to tangential tool force. When using any of the common types of tool materials such as carbon tool steel, high-speed steel, the cast cobalt-chromium alloys, or cemented carbide, there was no appreciable difference in the tangential tool force for any of the tool materials. When turning an S.A.E. 3140 hot-rolled steel with these tool materials, the cutting force was between 190 and 220 lb regardless of the type of tool material. The maximum cutting speeds used on these tests before failure occurred were 50 fpm for the carbon tool steel, 150 fpm for the high-speed steel, 300 fpm for the cast cobalt-chromium alloy, and 600 fpm for the tungsten-carbide tool. The depth of cut used for these tests was 0.050 in. and the feed was 0.0127 in. per revolution.

Tool Dulling and Failure. The type of wear on the tool will affect the tool forces. If the tool fails by cratering on the face of the tool, there will be a small decrease in tangential tool force as the tool wears. When failure occurs, a sharp increase in tool forces, as much as 100 per cent, will be obtained. If the cutting tool has light abrasion on the flank of the tool, an increase of 25 per cent in the tangential tool force, or power, will occur and tool failure will increase the tangential tool force to a total of 50 to 100 per cent above that of a new tool. Since the nomograph is intended for practical use, an allowance of 35 per cent was made for the dulling of the tool. For this reason, the horsepower required as indicated by the nomograph will be larger than that obtained by most theoretical or ideal power calculations. It is necessary to allow for this safety factor of 35 per cent to prevent the machine from stalling in the cut and thereby chipping or breaking the cutting tool. Even with this safety factor, the motor will have to stand considerable overload when the tool fails.

Material Cut. There is an approximate relationship between the Brinell hardness of the material cut and the tangential tool force as is shown in Fig. 6. The plain carbon steels, in general, require more power or higher force than the alloy steel. The free-cutting steels require the least force of any of the steels. The data, plotted on log-log co-ordinate in Fig. 6, show an average slope of 0.75. This would give an equation of $F_T = k \times (\text{Bhn})^{0.75}$. The power nomograph was designed to give power requirements for cutting plain carbon steels. If free-cutting steels are used, the power requirements will be approximately 40 per cent less.

Feed and Depth. Increasing the size of cut has practically a direct effect on the increase in horsepower or tangential tool force. In Fig. 7 are shown the values for tool forces when varying the feed and depth (3). When using tools having larger


TOOL LIFE
METAL CUTTING NOMOGRAPH
BY
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VELOCITY – FEET PER MINUTE
TOOL MATERIAL
CARBON TOOL STEEL
HIGH SPEED STEEL
CAST NON-FERROUS
CEMENTED CARBIDE
A--PRODUCT OF TOOL MAT'L & MAT'L CUT
MATERIAL CUT—BRINELL HARDNESS
S.A.E. X-1315
S.A.E. X-1020
S.A.E. 1045
S.A.E. 1020
S.A.E. 1112
S.A.E. X-1112
S.A.E. LOW ALLOY STEELS
C--PRODUCT OF A & B
TOOL LIFE—MINUTES
B--PRODUCT OF TOOL LIFE & DEPTH
DEPTH OF CUT—INCHES
FEED—INCHES PER REVOLUTION

SAMPLE CALCULATIONS
TOOL LIFE

GIVEN:
TOOL MATERIAL -------- HIGH SPEED STEEL
MATERIAL CUT -------- 180 B.H.N. - SAE 1020 STEEL
DESIRED TOOL LIFE ----- 60 MINUTES
DEPTH OF CUT ---------- 0.0625 INCHES
FEED ----------------- 0.0625 INCHES PER REV.

READ FROM CHART:
VELOCITY = 60.5 FEET PER MINUTE

FIG. 5 TOOL-LIFE NOMOGRAPH

radii, typical of commercial tools, the tangential tool force equation becomes $F_T = Cf^{0.8}d^{0.9}$. This equation indicates that it is slightly beneficial to increase the feed or depth of cut at the expense of cutting speed. This will increase the tangential tool force, but the power required to remove a unit amount of metal is reduced slightly for the heavier cut.

Tool Shape. The power nomograph shown in Fig. 8 was designed to show the power requirement when cutting a plain carbon steel without a cutting fluid and using the same shape of tool as was used in the tool-life tests. This tool had 8-deg back rake, 14-deg side rake, 6-deg relief angles, 6-deg end-cutting-edge angle 15-deg side-cutting-edge angle, and a small nose radius of $^3/_{64}$ in. If a larger nose radius or side-cutting-edge angle were used, it would have practically no effect upon tangential tool force or the horsepower required, but the radial tool force and the longitudinal tool force would be affected (3). If higher rake angles are used, the tool forces and the power required will be reduced. Rake angles lower than 14 deg will require more power (3).

Cutting Fluids. Cutting fluids have little effect upon the tangential tool force or the power requirements when cutting at high speeds but may reduce the power when low speeds are used. They are particularly useful in reducing tool forces when rubbing occurs between the flanks of the tool and the work.

Power Nomograph. By summarizing all of the foregoing factors, the following equation was determined for the power requirements

$$\text{Motor horsepower} \times \text{efficiency} = C_{\text{Bhn}} f^{0.8} d^{0.9} V$$

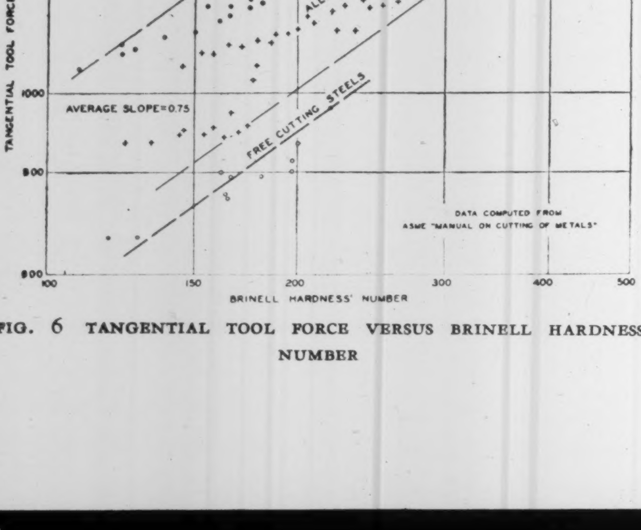
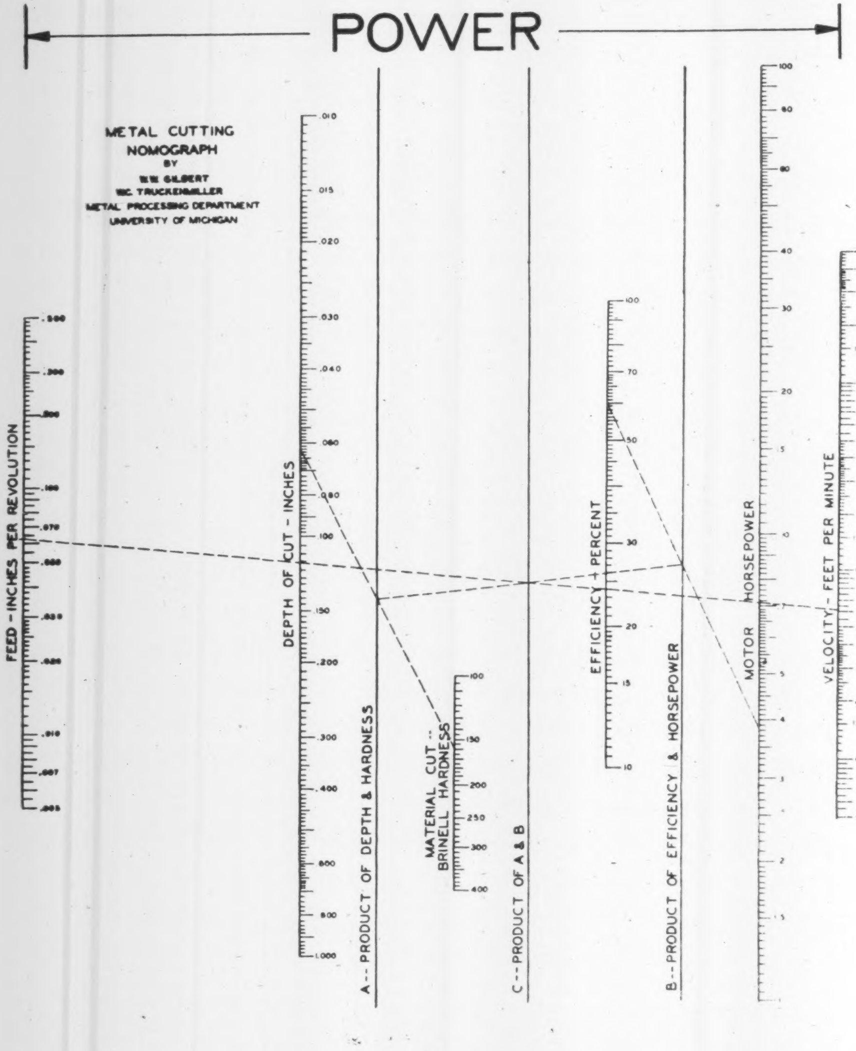


FIG. 6 TANGENTIAL TOOL FORCE VERSUS BRINELL HARDNESS NUMBER


POWER
METAL CUTTING
NOMOGRAPH
BY
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UNIVERSITY OF MICHIGAN
FEED - INCHES PER REVOLUTION
DEPTH OF CUT - INCHES
A -- PRODUCT OF DEPTH & HARDNESS
MATERIAL CUT -- BRINELL HARDNESS
C -- PRODUCT OF A & B
EFFICIENCY - PERCENT
B -- PRODUCT OF EFFICIENCY & HORSEPOWER
MOTOR HORSEPOWER
VELOCITY - FEET PER MINUTE

SAMPLE CALCULATIONS
POWER

GIVEN:
FEED ------------------0.0825 INCHES PER REV.
VELOCITY---------------60.5 FEET PER MINUTE
DEPTH OF CUT-----------0.0825 INCHES
MATERIAL CUT-----------180 B.H.N. - SAE 1020 STEEL
MACHINE EFFICIENCY ----80 PERCENT
READ FROM CHART:
MOTOR HORSEPOWER = 3.75

FIG. 8 POWER NOMOGRAPH

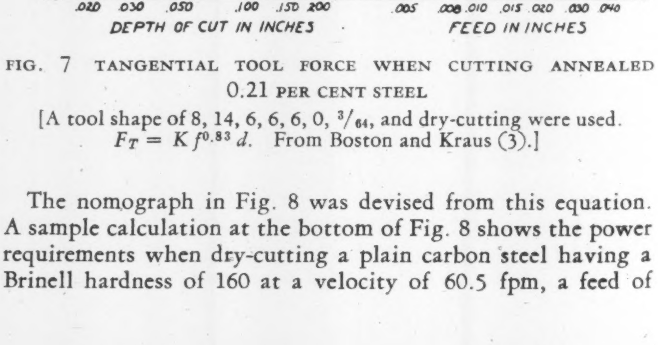
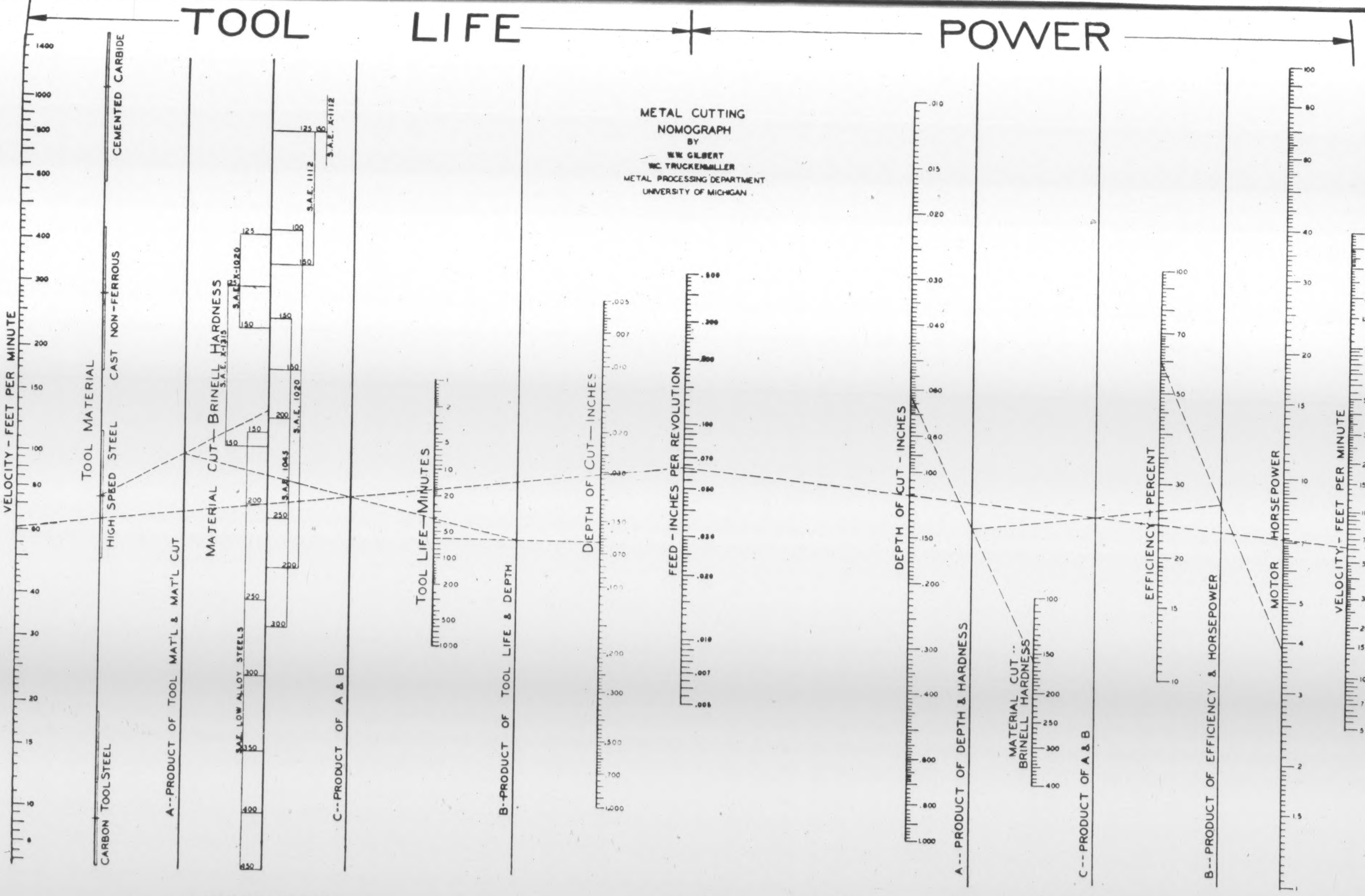


FIG. 7 TANGENTIAL TOOL FORCE WHEN CUTTING ANNEALED 0.21 PER CENT STEEL

[A tool shape of 8, 14, 6, 6, 6, 0, $^3/_{64}$, and dry-cutting were used. $F_T = K f^{0.83} d$. From Boston and Kraus (3).]

The nomograph in Fig. 8 was devised from this equation. A sample calculation at the bottom of Fig. 8 shows the power requirements when dry-cutting a plain carbon steel having a Brinell hardness of 160 at a velocity of 60.5 fpm, a feed of



SAMPLE CALCULATIONS
TOOL LIFE

GIVEN:

TOOL MATERIAL ---------- HIGH SPEED STEEL
MATERIAL CUT ---------- 180 B.H.N. - SAE 1020 STEEL
DESIRED TOOL LIFE ------ 60 MINUTES
DEPTH OF CUT ----------- 0.0625 INCHES
FEED ------------------- 0.0625 INCHES PER REV.

READ FROM CHART:

VELOCITY = 60.5 FEET PER MINUTE

MAXIMUM OUTPUT

GIVEN:

TOOL MATERIAL
MATERIAL CUT
TOOL LIFE
DEPTH OF CUT
(DEEPEST CUTS MOST EFFICIENT)
MACHINE EFFICIENCY
MOTOR HORSEPOWER
(USE RATED HORSEPOWER)

THE FEED SHOULD BE VARIED UNTIL THE VELOCITY ON THE TOOL LIFE SIDE IS EQUAL TO THE VELOCITY ON THE POWER SIDE. THIS FEED AND SPEED WILL GIVE THE MAXIMUM METAL REMOVAL FOR THE GIVEN CONDITIONS.

SAMPLE CALCULATIONS
POWER

GIVEN:

FEED ------------------- 0.0625 INCHES PER REV.
VELOCITY --------------- 60.5 FEET PER MINUTE
DEPTH OF CUT ----------- 0.0625 INCHES
MATERIAL CUT ----------- 180 B.H.N. - SAE 1020 STEEL
MACHINE EFFICIENCY ----- 60 PERCENT

READ FROM CHART:

MOTOR HORSEPOWER = 3.75

FIG. 9 COMBINED TOOL-LIFE AND POWER NOMOGRAPH

0.0625 in. per revolution, a depth of cut of 0.0625 in., and a machine efficiency of 60 per cent. From these given conditions, the required motor horsepower (determined by using Fig.8) is 3.75. This power requirement is larger than for most calculated results since there is an allowance of 35 per cent for the dulling of the cutting tool.

The construction of the power nomograph is similar to that of the tool-life nomograph in that, if five of the variables are known, the sixth variable may be computed. In this way, power requirements may be determined, or, if power available is known, the size of cut or the velocity may be determined.

MAXIMUM OUTPUT

To obtain maximum output, the cutting tool should have reasonable tool life and the power from the machine should not be high enough to cause the machine tool to stall or the motor to be damaged. By constructing the tool-life and the power nomographs with a common feed scale, it is possible to obtain a combined nomograph, shown in Fig. 9, which will give the maximum output on the machine. High machine output is obtained when heavy cuts are used. This nomograph will indicate that heavy feeds are desirable; the largest feed possible consistent with the strength of the cutting tool, the material cut, and the machine tool should be used. An acceptable surface finish may also limit the amount of the feed. When the feed is increased, it will cause a decrease in allowable cutting speed on both the tool-life and the power scales. The smaller of these two values of cutting speed should be used. Caution must be exercised in choosing the size of cut when operating a high-powered machine. Heavy cuts may break the cutting tool, the machine, or the work. Chatter may also occur if there is insufficient rigidity, and this may cause premature tool failure.

Sample calculations of tool life and power are given on the nomograph. The following example, which may be worked out on the combined nomograph, illustrates its use to determine maximum output of an engine lathe.

Given:

Material cut, S.A.E 1020 steel, Bhn 160
Tool material, cemented carbide
Desired tool life, 240 min (4 hr)
Depth of cut, 0.200 in
Machine efficiency, 60 per cent
Motor horsepower, 20

Find:

Feed and velocity for maximum output
Vary the feed until the velocities on the tool-life side and the power side of the combined chart are equal.

Read from chart:

Feed = 0.019 in. per revolution
Velocity = 280 fpm.

If the feed were increased beyond 0.019 in. per revolution, it would be necessary to reduce further the cutting speed to prevent overloading the motor. The tool life at this reduced speed would be more than 4 hours.

The main application of the combined nomograph is that many of the laws of tool life and power are incorporated in one simplified chart which is easy to use. The cutting speeds obtained by the nomograph are conservative, but should materially assist in estimating the speeds and feeds for giving higher production rates.

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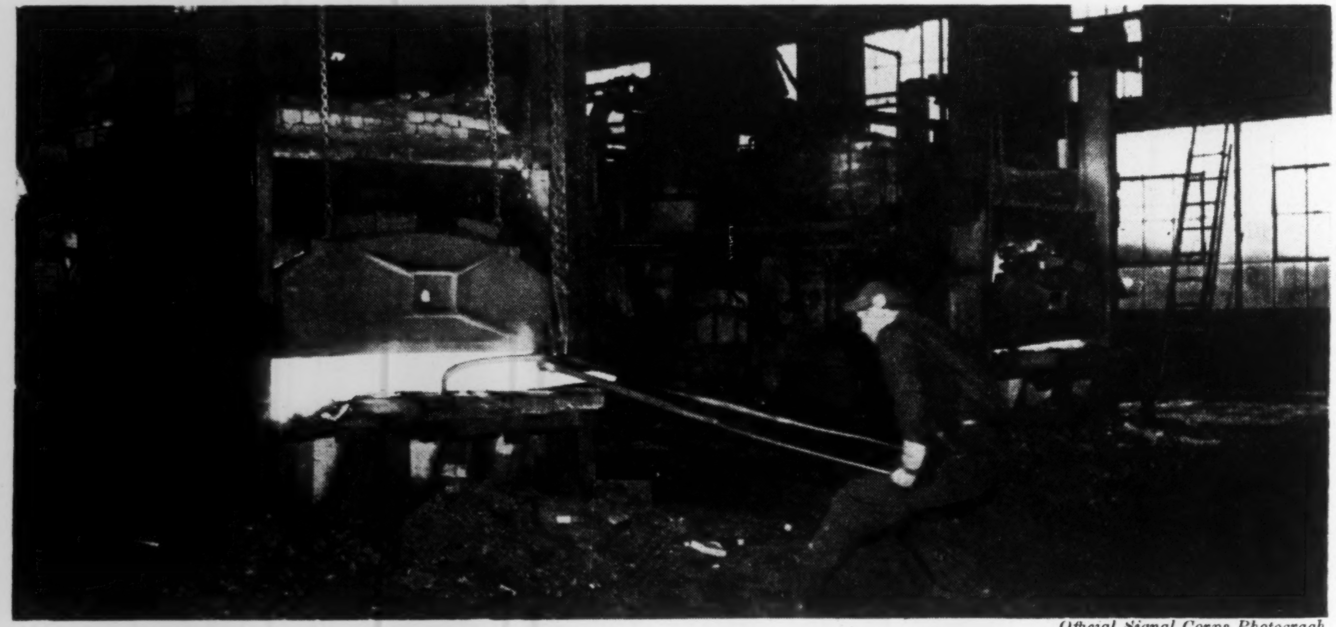

Official Signal Corps Photograph

START OF A 500-LB AIRCRAFT BOMB

LICENSES UNDER PATENTS

Vested by the Alien Property Custodian

By K. A. MAYR, NEW YORK, N. Y.

PATENT ATTORNEY, MEMBER A.S.M.E.

THE Alien Property Custodian has vested about 40,000 patents and patent applications of enemy nationals or nationals of enemy-occupied countries. He is prepared to grant royalty-free, nonexclusive, nonassignable, and revocable licenses under patents vested from nationals of countries with whom we are at war. The fee now is $15 for each license under one patent and for the life of the patent. Licenses under patents from nationals of enemy-occupied countries are of the same type except that they are royalty-free only for the duration of the war plus six months, and thereafter royalty-bearing on the basis of prevailing commercial practice.

Vested patent applications are prosecuted by the Alien Property Custodian, and, if allowed, are issued to this authority. Some jurists doubt whether these patents are valid.

It is the policy of the Alien Property Custodian to recognize outstanding licenses held by United States citizens at the time the patents were vested and in so far as the national interest permits. If such licenses are exclusive, no licenses can be granted to other parties. Outstanding exclusive licenses may, at the request of the licensee, be converted into standard nonexclusive licenses. Necessity to the war effort overrides any outstanding prevesting arrangement.

The purpose of a patent, according to the Constitution, is to promote progress of science and useful arts. The purpose of the procedure of the Alien Property Custodian is to make inventions covered by patents vested by him available to every American. With respect to the latter purpose the licensing policy of the Alien Property Custodian appears to be an undesired restriction, and there is at least one jurist who is of the opinion that a patent owned by our government, i.e., we, the people, is owned by we, the people, and, therefore, everybody can use it without first obtaining a license. In that case it is questionable whether the patents can serve their original purpose—to promote progress of science and useful arts.

In order to make a patent serve science and useful arts, extensive laboratory and manufacturing facilities, as a rule, are required, and in order to make the benefits of an invention available to everybody, the patented article must be manufactured and distributed on a large scale and at a low price. To accomplish this, depending on the nature of the invention, a more or less great capital investment is needed. This is the more true if the patent discloses only the fundamental idea of an invention and not much as to how to produce the article on a commercial scale, i.e., if there is little disclosure of "know-how" in the patent.

Almost all vested patents are based on European patent applications and the requirements of European patent offices as to disclosure are less strict than those of our Patent Office. Though U.S. patent attorneys prosecuting the patent applications, the patents resulting from which are now vested, did their best to rewrite the specifications to introduce a complete description of an embodiment of the inventions which can be carried into practice by a man skilled in the art as required by our patent law, a great number of these patents do not tell the manufacturer all the "know-how" which is necessary to make the inventions work commercially.

For the foregoing reasons, an industrialist may have to spend from $5,000 to $500,000 or even more, depending on the nature of the invention, to develop it for manufacture and practical use in the United States.

A person cannot make such a large investment unless he is reasonably sure that after the invention is in the form of a salable product he will be the one who sells it and receives credit for his labor and expenses. The Alien Property Custodian gives a license to practically everybody who pays $15 per patent. One party may acquire such a license when another has already spent large sums of money for developing the invention and the later licensee may copy the fully developed invention and reap the harvest which really belongs to the earlier user of the invention. The Alien Property Custodian expects that a licensee will further develop the invention and obtain patents on such improvements and, in this way, receive exclusive rights. To follow this policy calls for multiplication of improvement efforts which may cause much more waste than beneficial results. It must not be forgotten that the vested patents originated from abroad and a foreigner usually does not go through the, at least for him, rather expensive procedure of obtaining a U.S. patent, unless he has a case which is sufficiently strong to justify such expenses, and in such a case making of patentable improvements adapted to secure the desired exclusiveness is not an easy matter. Very few are willing to pay anything for a license which anybody else can also have for the same, however low, price; and nobody can afford to put up the much larger amount of money and the labor necessary for making a marketable product out of such an invention, for advertising it and building up a sales organization, as long as he is not sure that his neighbor is not working on exactly the same thing. The result would be wasteful duplication and possibly bankruptcy of both parties.

These conditions would be still more aggravated if the vested patents were to be available to everybody without a license whatsoever and it is not seen how in this way the original purpose of the patents could be fulfilled and the public could be served. The fact that, so far, very few licenses have been applied for or granted under the vested patents appears to prove the foregoing contention.

In normal license negotiations, responsible parties usually make no secret of their license agreements; anybody can find out who is doing something under a certain patent and he then can decide whether he has a chance to compete. Whereas the Alien Property Custodian may reveal the existence of licenses, he does not divulge the identity of any of the licensees.

Only when a party can obtain exclusive rights at least for a certain period of time or territory or field of application, can it take the risk of making a large investment. Our antitrust laws are good enough to prevent anyone's making an undue profit at the expense of the public out of its exclusive rights. Suitable provisions can be made in exclusive or limited exclusive licenses for their conversion into nonexclusive licenses unless certain stipulated conditions are met by the licensee, and the public could be protected in this way also.

Some manufacturers, of course, do not think much of patents because many patents are issued on ideas which may have been of utility to the inventor at the time he made the invention but which have a very limited application, at least at the time they are offered. This objection has a reduced weight with respect to the patents vested by the Alien Property Custodian, because, as said before, it was difficult for a European to take out a U.S. patent and he did not do it unless the invention had commercial value. Usually, the U.S. patent application was made on the basis of an application already examined in a European patent office and the U.S. patent was taken out only if the prosecution of the corresponding European application showed a reasonable chance of success. For this reason, it would be regrettable if these rather valuable inventions, which, according to the Alien Property Custodian, "are a permanent possession of the American people," should remain in printed form only.

The Alien Property Custodian, depending upon the facts, may continue license negotiations begun by United States citizens and which were interrupted by the war conditions. This should be interesting to importers who imported in prewar days from now enemy countries machinery which was covered by now vested patents. Such importation was often under an exclusive sales agreement and with the understanding that, should transportation of the devices from Europe or importation into the United States or both become impossible, these importers would be the ones to have also exclusive manufacturing rights under the patents. These agreements are seldom in writing as the Nazi government, for example, would, in many cases, not have permitted such an agreement. The patents are now owned by the Alien Property Custodian and he is the only one who can confirm such unwritten license agreements.

In most of the more recently issued vested patents and in vested patent applications the American attorney's fees have not been fully paid by the previous owners. Other expenses and claims are connected with a number of the vested patents, for example, expenses for development work incurred by prospective prewar licensees when negotiating for licenses under what are now enemy patents. These negotiations and development work had to be stopped when the Alien Property Custodian took the patents over, since the prospective licensee could not continue his work because of the great risk associated with developing the inventions under the policy adopted by the Alien Property Custodian. These liabilities must necessarily be taken over by the new owner of the patents, and as long as they are not properly taken care of, an honest business hesitates to have anything to do with such matters.

There are, of course, many vested patents for inventions relating to simple devices or methods which can be easily adapted to American manufacturing and marketing conditions. In these cases the licensing policy of the Alien Property Custodian, which provides a certain protection, in that the Custodian defends his licensees against infringers, is perfectly suitable and preferable to either giving the patents away without any restrictions or granting only a limited number of licenses, or territorially or otherwise restricted or fully exclusive licenses with the danger of creating an undesired monopoly. The licensing policy of the Alien Property Custodian, or even a still more unrestricted policy, is also most desirable—for the duration—in the case of all inventions which contribute to the war effort.

For the great number of inventions which require considerable investment for making them useful to the public, the policy appears to have a detrimental effect and a tendency to undermine our patent system and the dignity of our patents. After all, the vested patents are also a creation of our government, i.e., we, the people, and they should be used for the benefit of the people and not be deteriorated in such a way that they become useless.

There is no doubt that, as time goes on, the Alien Property Custodian will make his policy more flexible to take care of the great variety of conditions associated with the individual inventions, and a way will be found so that the great number of vested patents, which appear to be particularly useful for converting our vast industrial facilities to peacetime conditions and providing work for our returning fighters and warworkers, can be put to work for the benefit of all.

JOINING A PROFESSIONAL SOCIETY[1]

By DUGALD C. JACKSON,

CAMBRIDGE, MASS. FELLOW, A.S.M.E.

WHY does one join a professional society?

For the satisfaction derived from the associations, for the pleasure of acquaintances made and some warm friendships derived as a result of the contacts at meetings and through correspondence, for the joy of debate with one's equals or one's betters at meetings. These are all causes that have pleasure and great value for young men and continued pleasurable satisfaction for the older ones. A prideful possession and prompt reading of the best writings in one's field also leads to a wish to have the society publications promptly and at first hand, which is the pleasure and privilege of a member. A reason less sentimentally compelling in our individualistic country is the favorable influence on one's standing which arises from officially ranging oneself alongside of professional and scientific fellows; but this may be considered as a reasonable duty. Lord Bacon long ago observed (in discussing his Maxims of the Law) that "I hold every man a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereto." Were he living today, I have no doubt that Lord Bacon would repeat this maxim of his. From this aspect, one should not be content to always remain in the junior ranks of membership, but should request transfer to the more established grades as age and accomplishment provide eligibility.

In matters of personal and professional association, such as are here under consideration, one takes out of a situation in proportion to what he puts in; but paradoxically one seems to receive more than he gives when trying in reasonable measure to give more than he receives. It therefore does not suffice for a young man to just "join." If he wishes to enjoy and also profit from the advantages of a professional society, he must take a part in the affairs of the society. This means some discussion of papers orally or by letter, writing of papers, attending some meetings, and taking part in the Section government. This attracts friends. It also, when done with some wisdom, provides experience of unfailing serviceability. The phrase "with some wisdom" refers not only to the manner of doing but also to carrying on without interfering with one's duty to one's employer.

Membership in professional societies costs money for annual dues, and attendance on a convention once in a while also involves cost even if normal expenses are paid by one's employer. For the young engineer who is ambitious to progress in reputation, responsibility, and pay, these expenses are items for serious thought, especially after he has married. The wife may not see any concrete influence on the future as likely to come from the expenditure of either money or time. Needed new shoes of a prettier style for the baby and some time to make minor repairs

(*Continued on page 904*)

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[1] Reprinted from *Tech. Engineering News*, November, 1927. Slightly modified.

CUTTING-ANGLE RELATIONSHIPS *on* METAL-CUTTING TOOLS

By M. KRONENBERG

THE CINCINNATI MILLING MACHINE CO., CINCINNATI, OHIO

With the introduction and wide commercial use of exceedingly tough and hard alloy steels such as now generally employed in tanks, guns, and armor plates, difficult machining problems have been presented to industry. In consequence, much more attention has recently been given to the mechanism of chip flow and proper selection of tool angles.

As the angle of greatest importance in metal cutting is the true rake angle t (see sketch on Figs. 1 and 2), it is highly desirable from the standpoint of both the production engineer and shop man to provide means for easy determination of this angle from its commonly expressed components such as side rake and back rake in the case of a lathe tool, or radial rake r and axial rake a in the case of a face mill.

The importance of the true rake angle has been more generally recognized since the advent of cutting tools with negative values for either or both of the component rake angles. These component angles can usually be easily measured, but their individual effect on the true angle is complicated by the fact that the direction of chip flow is always perpendicular to the cutting edge, thus an additional component angle enters the problem which must be taken into consideration, viz., the angle between the cutting edge and the axis of the cutter called "corner angle" c. In the case of a lathe tool this angle corresponds to the effective side-cutting-edge angle. The direction of chip flow can be controlled by changing the corner angle c as will be seen in detail later on.

The true rake angle t is the actual slope of the tool face, in the direction of chip flow, with respect to a plane passing through the axis of rotation of the cutter and the point of the tool, or a plane parallel to it, and is measured perpendicular to that plane. The great significance which the true rake angle possesses in the machining process is due to the fact that it directly affects not only the cutting force but also the finish of the work and the tool life.[1]

Alignment charts Figs. 1 and 2 have been prepared to facilitate the determination of the very complex relationships between the angles at the cutting edges of a tooth in a face mill. They refer also to lathe tools if the terms "axial" and "radial" are replaced by "back" and "side" rake, respectively.

DERIVATION OF FORMULA

The derivation of a formula connecting the four angles will be seen from Fig. 3, where the center sketch represents the top view of a tooth having a corner angle c. Line Q-P indicates the direction of chip flow. Triangle QRP is assumed to be located in a plane parallel to the reference plane passing through point s of the tooth and the axis of rotation. Tipping side RP of triangle QRP about Q parallel to itself will shift point R, to R' through angle r representing the radial rake, thus

$$RR' = w \cdot \tan r = x \cdot \cot c \cdot \tan r \ldots\ldots\ldots\ldots [1]$$

On the other hand, tipping point P of triangle QRP about side QR will shift point P to P', through angle a representing the axial rake, thus

$$PP' = x \cdot \tan a \ldots\ldots\ldots\ldots [2]$$

Combining these two shiftings will result in a total motion of point P from P to T, i.e., through the true rake angle t.

From the geometry of Fig. 3

$$PT = \frac{x}{\sin c} \cdot \tan t \ldots\ldots\ldots\ldots [3]$$

RR' is the distance of the reference plane from plane QR' having the slope of the radial rake; PP' represents the additional distance between plane QR' and the the face of the tool, thus

$$RR' + PP' = PT \ldots\ldots\ldots\ldots [4]$$

Hence by substituting Equations [1], [2], and [3] into [4]; and by rearranging

$$\tan t = \tan r \cdot \cos c + \tan a \cdot \sin c \ldots\ldots\ldots\ldots [5]$$

ALIGNMENT CHARTS

Alignment charts, Figs. 1 and 2, are the graphical representations of Equation [5] permitting the reading of the value and variation of any one of the angles if the three other angles are given or varied. Fig. 1 refers to cases where the corner angle c is between 0 and 45 deg, Fig. 2 covers cases where c is between 45 and 90 deg. *It is only necessary to draw on the charts a straight line connecting the given angles.* If the true rake angle is to be determined, the given value of the axial rake a should be connected by a straight line with the given value of the radial rake r, then the true rake angle t can be read for any value of the corner angle c at the intersections of the straight line with the vertical "c" lines.

On the other hand, if a certain value of the true rake angle t is desired and angles c and r are given, the required axial rake a can be determined by connecting the t-c intersection with the r value. The axial rake a can then be read on the a-scale. Correspondingly, the required radial rake r can be determined if t, c, and a are given.

Example 1:

Assuming a face mill with a *positive* axial rake of $a = +10$ deg and a *negative* radial rake of $r = -5$ deg.

A straight line (marked "example") passing through these values on Fig. 1 intersects the vertical c-line for $c = 45$ deg at $t = +3^1/_2$ deg, which indicates that the true rake angle is $3^1/_2$ deg positive if the corner angle is 45 deg.

It can easily be realized by tracing along the straight line, that the true rake angle t will vary if the corner angle c is varied. The example line intersects the horizontal zero line at $c = 27$ deg, showing that the true rake angle will be zero if the corner angle c is made 27 deg. For corner angles smaller

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[1] "Chip Formation, Friction and High Quality Machined Surfaces," by H. Ernst and M. E. Merchant. Paper presented before the 22nd annual convention of the A.S.M., Cleveland, Ohio, October, 1940, published in "Surface Treatment of Metal," American Society for Metals, 1941, pp. 299–378.

Contributed by the A.S.M.E. Research Subcommittee on Physics of Metal Cutting for presentation at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of The American Society of Mechanical Engineers.

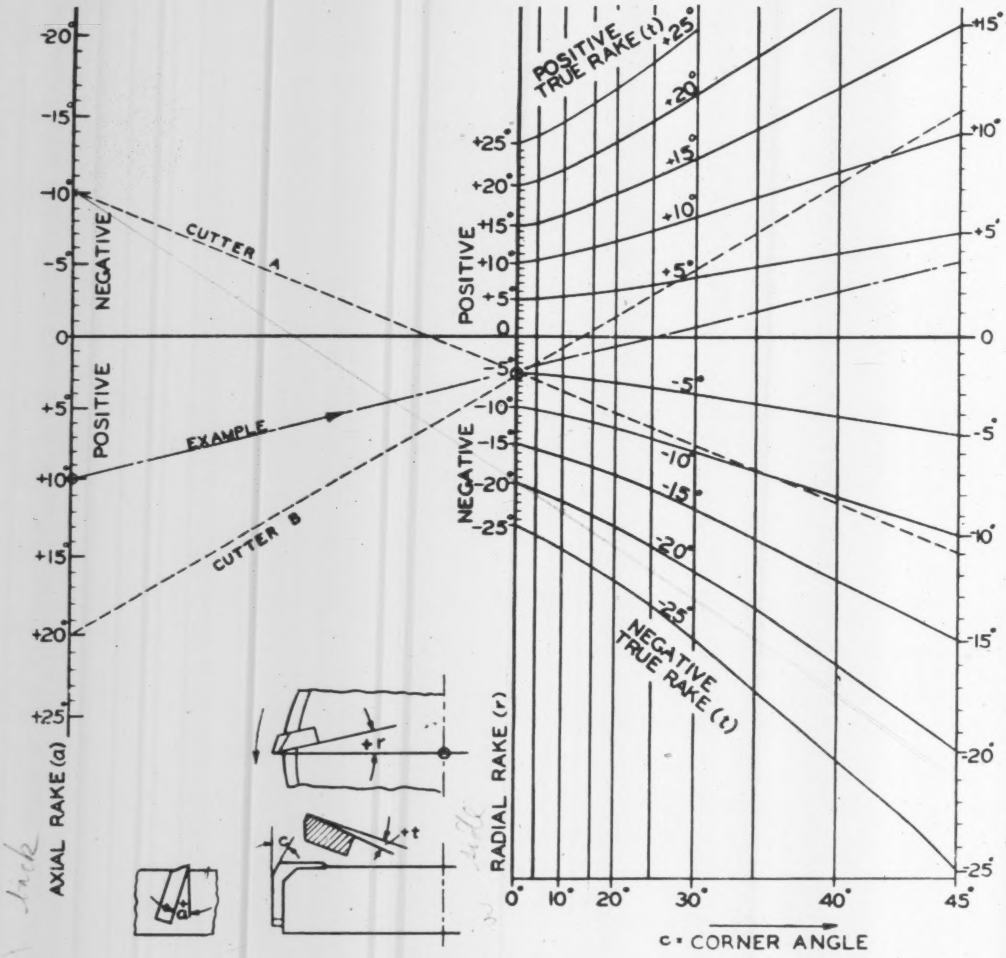

FIG. 1 ALIGNMENT CHART FOR THE RELATIONSHIP BETWEEN CUTTING ANGLES FOR CORNER ANGLE $c \leqq 45$ DEG

($\tan t = \tan r \cdot \cos c + \tan a \cdot \sin c$.)

than 27 deg the true rake angle t at the cutting edge of this cutter will be *negative*, while t will be *positive* for corner angles larger than 27 deg.

In the case of a cutter with two different corner angles of, say, $22^1/_2$ deg and 45 deg, respectively, two different true rake angles will be obtained; the true rake angle at the $22^1/_2$-in. cutting edge will be *negative* (—1 deg), while that at the 45 deg corner will be *positive* ($+3^1/_2$ deg).

Continuing the example on chart Fig. 2 for corner angles c larger than 45 deg: Fig. 2 is basically the same diagram as Fig. 1, with the exception of having the r and a scales exchanged and the c-scale running from right to left. Here again the r and a values are connected by a straight line. It will be seen that the true rake angle t will be +5 deg if c = 53 deg, etc.

Using both charts in conjunction will permit exploring the variation of the true rake angle in cases of continuously changing corner angles, i.e., if the tooth has a curved cutting edge. In the case of the example, therefore, the true rake angle will be negative until the tangent to the curved cutting edge reaches a value of 27 deg; from there on the true rake angle will be positive and reach a value of t = +10 deg at the face, i.e., at c = 90 deg (see Fig. 2).

Examples 2 and 3:

Two more examples are shown on the charts, representing cases of two commercial cutters A and B, the true rake angles of which can be explored in the same way as already described. In the case of cutter A, the true rake angle at a 45-deg corner will be —11 deg, as against +11 deg for cutter B.

Three different combinations of the axial rake a and radial rake r are possible, viz.:

(1) The conventional combination, where both a and r are *positive*; (2) A combination where both a and r are *negative;* (3) A combination where one rake is *positive* and the other *negative.*

Various conclusions can be attained for these combinations by exploring the charts. These conclusions are listed at the end of this paper.

POSITIVE AND NEGATIVE MAXIMA FOR THE TRUE RAKE ANGLE

Differentiation of the basic Equation [5] reveals that there are positive and negative maxima for the true rake angle, a fact of particular interest because it gives a new aspect to the problem as to what is happening at the cutting edge.

The true rake angle t will be a maximum if

$$\tan c_{\max} = \frac{\tan a}{\tan r} \qquad [6]$$

The actual value of the maximum is

$$\tan t_{\max} = \pm \sqrt{\tan^2 r + \tan^2 a} \qquad [7]$$

where the positive sign refers to cases where both the radial rake r and the axial rake a are positive (conventional rake combination), while the negative sign holds for cases where r and a are both negative, as in the case of cutter A.

On the other hand the true rake angle will be zero, if

$$\tan t = 0 \qquad [8]$$

This will be the case if according to Equation [5]

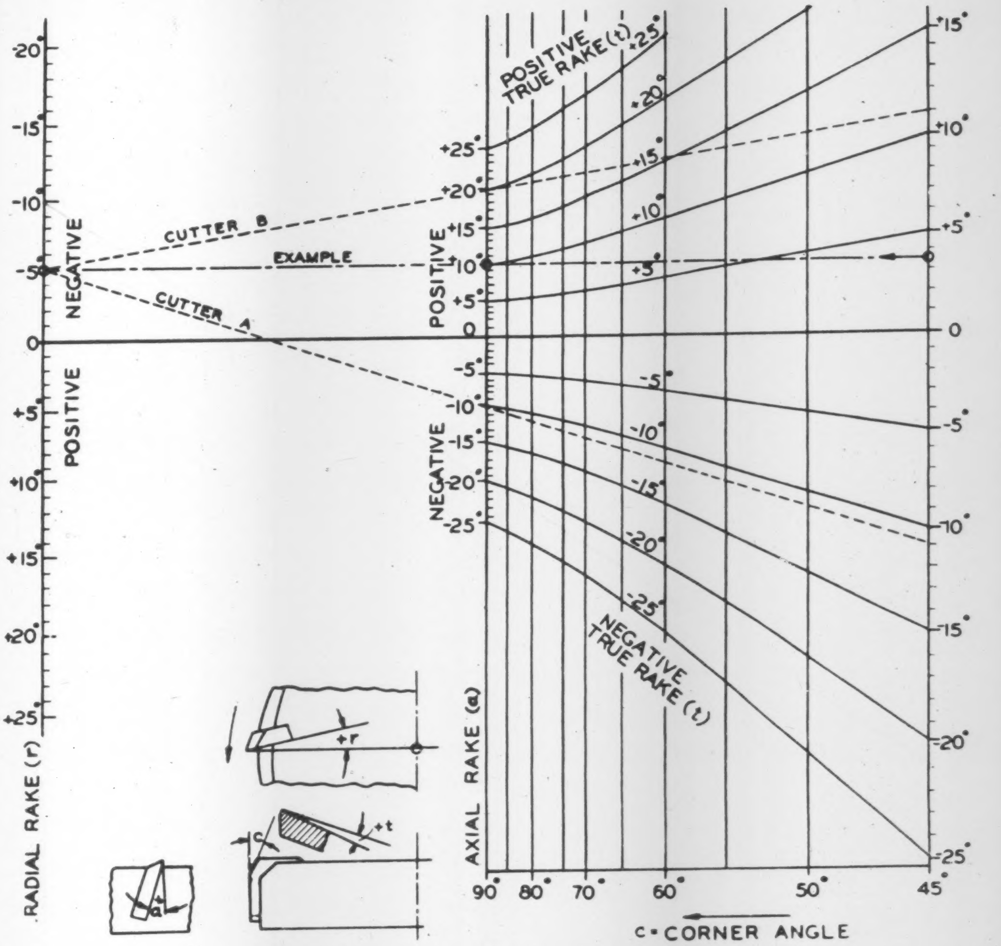

FIG. 2 ALIGNMENT CHART FOR THE RELATIONSHIP BETWEEN CUTTING ANGLE FOR CORNER ANGLE $c \geqq 45$ DEG ($\tan t = \tan r \cdot \cos c + \tan a \cdot \sin c$.)

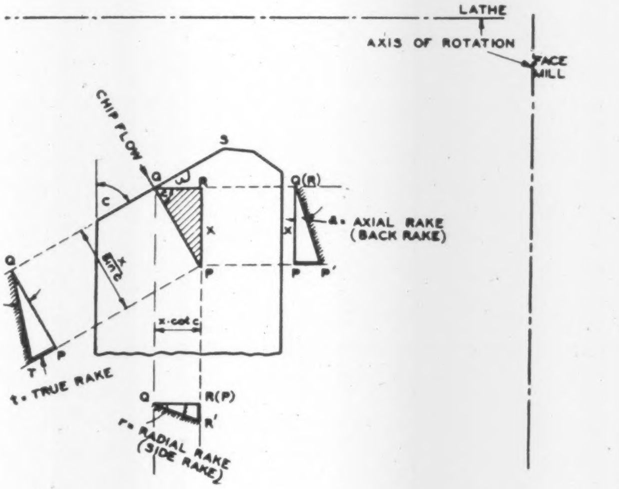
LATHE
AXIS OF ROTATION
FACE MILL
CHIP FLOW
S
Q
R
ω
c
x
Q(R)
a = AXIAL RAKE (BACK RAKE)
x
P
P'
Q
x/sin c
x·cot c
T
P
t = TRUE RAKE
Q
R(P)
R'
r = RADIAL RAKE (SIDE RAKE)

FIG. 3 DERIVATION OF THE BASIC FORMULA TAN t = TAN $r \cdot$ COS c + TAN $a \cdot$ SIN c

$$\tan a \cdot \sin c = -\tan r \cdot \cos c$$

$$\tan c_0 = -\frac{\tan r}{\tan a} \qquad [9]$$

Equation [9] indicates that the true rake angle t can become zero only if one of the rakes is negative, and the other positive, of if both the corner angle and radial rake be zero.

It is also evident from Equation [6] that a corner angle of 45 deg will not always produce the largest positive or negative true rake angle $t_{\max}$ but only if the radial and axial rake are equal and of the same sign, because only then $\tan c = 1$, corresponding to $c = 45$ deg. This will also be seen from Fig. 4, representing the maximum values for the true rake angle as a function of the three other angles. The example marked on the diagram indicates that the maximum true rake angle for

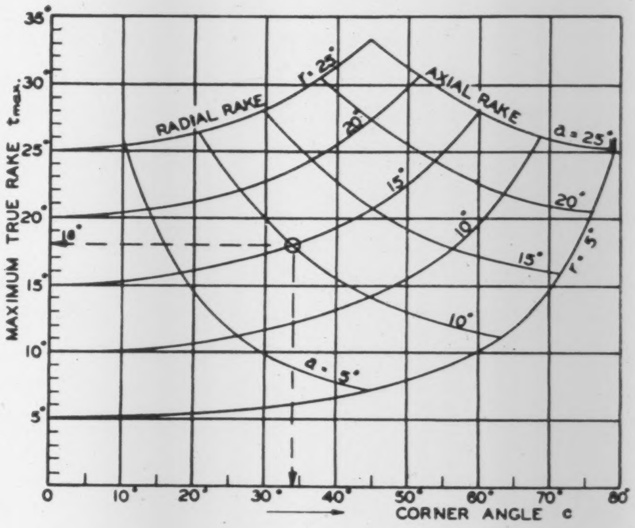

FIG. 4 MAXIMUM VALUES FOR THE TRUE RAKE ANGLE t IF BOTH AXIAL AND RADIAL RAKE ARE EITHER POSITIVE OR NEGATIVE

a radial rake r of ±15 deg and an axial rake a of ±10 deg will occur at a corner angle c of 34 deg and will have a magnitude of ±18 deg ($t_{\max}$).

Similarly, equation [9] shows that a 45-deg corner angle will produce a zero true rake angle only if the radial and axial rakes are equal and of opposite signs.

Since the shear angle ϕ in Fig. 5[1] increases with increasing values of the true rake angle, and since the cutting force decreases as the shear angle increases, it follows that the cutting force will be a minimum if the corner angle is selected from Fig. 4 so as to produce a maximum true rake angle for the selected values of radial and axial rake, provided, of course, that both of these rake angles are either positive or negative.

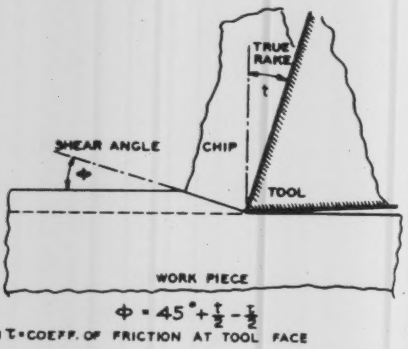
TRUE RAKE
t
SHEAR ANGLE
ϕ
CHIP
TOOL
WORK PIECE
$\phi = 45° + \frac{t}{2} - \frac{\tau}{2}$
TAN τ = COEFF. OF FRICTION AT TOOL FACE

FIG. 5 RELATIONSHIP BETWEEN SHEAR ANGLE ϕ AND TRUE RAKE ANGLE t

Where the axial rake is positive while the radial rake is negative, as in the case of cutter B the maximum true rake angle will occur with the maximum possible value of the corner angle (i.e., 90 deg). If the shape of the cool is a curve, the true rake angle will vary all along the cutting edge. The cutting force, therefore, will be nonuniform along the edge, which is advantageous from the standpoint of chatter, but not so from the standpoint of obtaining the smallest cutting force and smallest heat generation. In the case of a curved cutting edge (or in the case of a tooth having several corner angles), the depth of cut will play an important role too, because its value will determine the range of true rake angles which will be utilized.

CONCLUSIONS

The following important conclusions governing the relationship between the true rake angle and its component angles can be drawn from the foregoing and also easily be seen from the alignment charts:

1 A simple method to change the magnitude of the true rake angle is the grinding of a different corner angle on the tooth. In the case of a plus-minus combination of the radial and axial rakes, the true rake angle can thus be made either positive or negative.

2 There can exist on the same tooth two (or more) different true rake angles if the tooth has two (or more) different corner angles. These different true rake angles will both be positive if the radial and axial rakes are both positive (and vice versa); the true rake angle at one corner can be positive, the other negative if the radial rake is positive and the axial negative, or vice versa. The true rake angles can, however, also be all positive or all negative, depending upon the magnitude of the corner angles. The depth of cut will determine the range of true rake angles which will be utilized.

3 In the case of a curved contour of the cutting edge, the true rake angle varies along the curved portion. It increases to a positive maximum at a definite value of the tangent to the curve and decreases thereafter if both rakes are positive. It increases to a negative maximum and decreases thereafter if both rakes are negative. Such a maximum, however, will not be attained if the two rakes have opposite signs. Then the true rake angle will change sign along the cutting edge, and will pass through zero true rake angle at a definite point of the curvature.

4 In the case of a straight cutting edge it is possible to obtain the largest true rake angle, for given values of axial and radial rake angle, by selecting one definite corner angle for each positive-positive or negative-negative combination of the rakes. The corner angle giving the largest true rake angle is 45 deg only if the positive (or negative) values of the two rake angles are equal.

A true rake angle of zero degree will be obtained by selecting one definite corner angle in the case of the positive-negative rake combinations. This corner angle is 45 deg only if one of the rakes is as much positive as the other is negative.

5 The true rake angle will always be positive if the axial and the radial rakes are *positive*. It will always be negative if the two rakes are *negative*.

The true rake angle, however, can be positive, even though the axial or radial rake be negative.

Alignment charts, calculations, and conclusions hold also for the case of lathe tools, if the term "axial rake" is replaced by "back rake" and the term "radial rake" is replaced by "side rake."

Joining a Professional Society

(*Continued from page 900*)

to household equipment are concrete and present needs. I know, for I have been through it. When I was a cub engineer my wife called me a "joiner" (I was an associate member of American Institute of Electrical Engineers before being married but joined other societies later); but we agreed together then and still agree that the time, effort, and money expended for the societies has been fruitfully, indeed prolifically, recompensed by the desirable associations, friendships, and business relations which have been an outcome. This personal point is put in for encouragement, not as an example. I would not say to any young man, go thou and do likewise. Each young man must reason out his career for himself. But with respect to the professional societies, the young man who complains that his society does nothing for him is one who does nothing for the society. The professional societies are not unions to which one pays dues in support of agents to watch wages and working conditions and fight to keep them up. They are of the character of the clubs and small societies that Benjamin Franklin was fond of forming and participating in. They are societies for mutual association, for improvement of the members by mutual relations, and for advancement of the profession by disseminating knowledge. It is the acts of the members themselves that make the usefulness of these professional societies to the individual participants, as well as at large.

A word on a collateral matter may not be out of place. For young men following in the engineering school a course of study of definitely scientific fabric, reading the papers on scientific and application subjects of the Journal of one's engineering society or societies is wisely fortified by systematic examination and some discussion of articles and descriptions printed in commercial journals. This is a means of securing a fuller knowledge of the practice and applications of today that form the ground work on which are set the improvements arising from scientific discoveries and scientific analysis. These improvements will compose the greater scope of the applications and practice five years hence when our present students are industriously biting into the practical affairs of their engineering life.

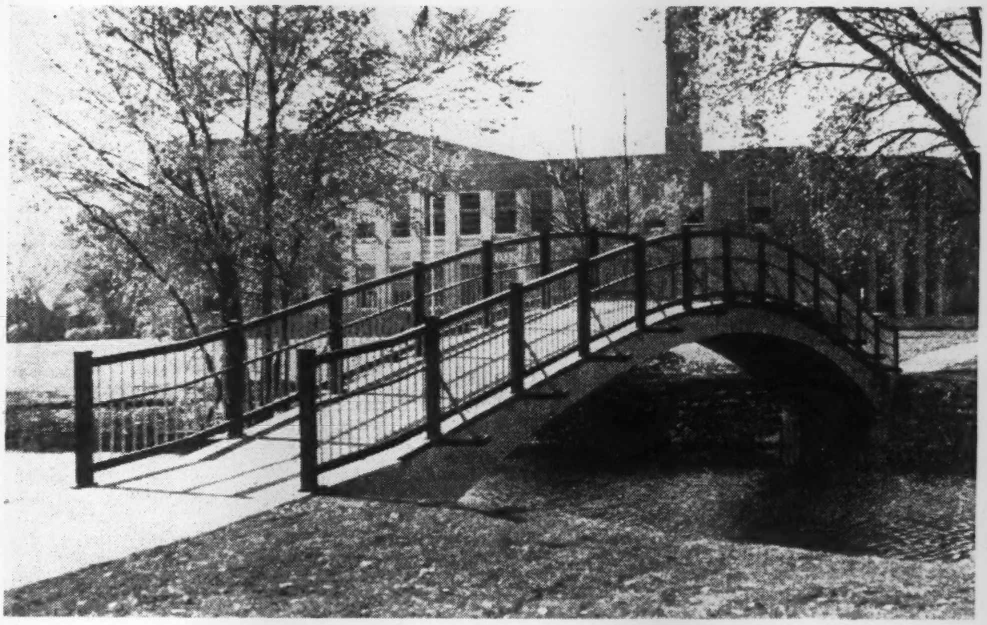

FIG. 1 GLUED-LAMINATED 78-FT ARCHES IN JENNIFER STREET FOOT BRIDGE, MADISON, WIS.

GLUED-LAMINATED LUMBER CONSTRUCTION

By FRANK J. HANRAHAN

NATIONAL LUMBER MANUFACTURERS ASSOCIATION, WASHINGTON, D. C.

THIS war has brought about in the United States the most extensive industrial expansion ever experienced by any country in a comparable period of time. A large part of the building needed to house this enlarged industrial plant has been of lumber. Had it not been for two modern developments, namely timber connectors and glued-laminated construction, much of this building would not have been possible in wood, and it would have been necessary to divert large quantities of critical metals from urgent military needs to do the job that lumber has done. Fortunately, research, design, and fabricating procedure of both innovations had been perfected prior to the war, which made possible meeting the challenge of this enormous program.

The War Production Board has estimated that, in 1942, 800,000,000 pounds of structural steel were saved by timber-connector construction alone. This figure is the net saving of metal after deduction of metal used in fastenings. It refers only to those structures which normally would be built of metal and does not include those which normally would be wood. A parallel figure is not available for glued-laminated construction, but this method of lumber fabrication has also scored a substantial saving.

Even before the war, both types of wood construction were rapidly encroaching into the field of construction previously thought practical only in steel, on merit and economy in direct competition with steel. This war-construction program has made engineers familiar with wood and its merits as a structural material. After the war, this technical knowledge of modern timber construction cannot do otherwise than accelerate the trend, evident before the war, toward more wood construction. That is, wood construction will be considered on the basis of its merits—not on the basis of prejudice born of ignorance. The wise industrial executive who is expanding or remodeling his plant, office, storage, or distribution facilities will insist that the advantages and economies of wood as well as those of other structural materials be investigated.

VERSATILITY OF STRUCTURAL LUMBER

Structural members of a size, shape, and quality which could never be sawn as single pieces from the largest and best trees ever grown are commonplace today. Modern glues, as strong and durable as the wood itself, have made this possible (see Figs. 1, 2, 3, and 4).

Strange as it may seem, the preparation of lumber for structural purposes has taken two diametrically opposite directions. For many years it has been customary to make smaller pieces of lumber from larger timbers or logs. Now, with the advent of glues meeting the requirements of any condition of service, the opposite process of making large timbers out of smaller pieces is growing by leaps and bounds.

Fortunately, with the forest-conservation measures under way, our country need not fear exhaustion of the wood supply, which is our greatest renewable natural resource. Some industrial lumber operations are set up on a permanent basis whereby enough forest land is farmed to permit continuous harvesting of the tree crop. In other words, by the time the land has been completely cut over once, the tree crop on the

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Contributed by the Wood Industries Division for presentation at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

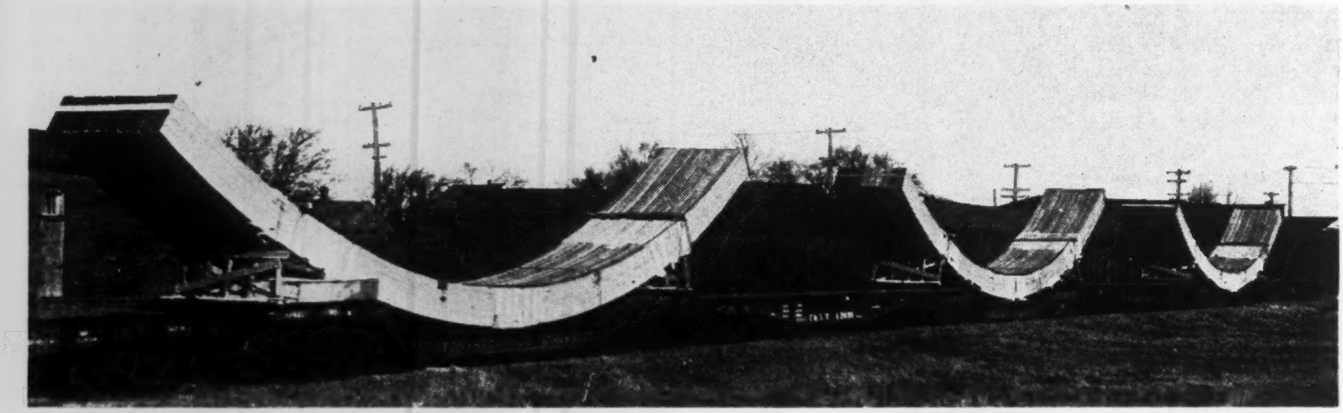

FIG. 3 LARGE SEGMENTS OF GLUED-LAMINATED ARCH IN SHIPMENT

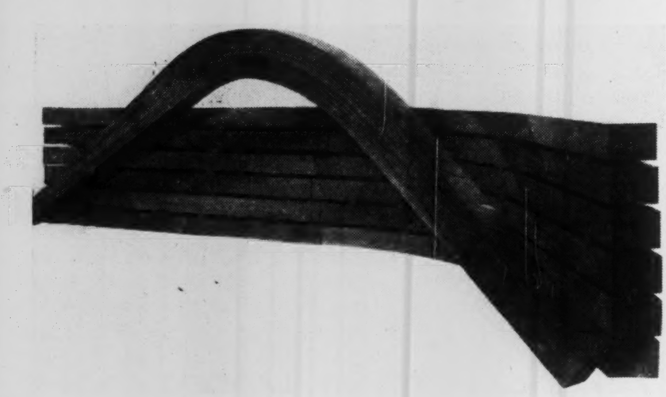

FIG. 2 TAPERED GLUED ARCHES FOR CAFETERIA, SHOWING GRADATION IN LAMINA FROM 13 AT TOP, TO 27 AT ELBOW, AND 19 AT BASE

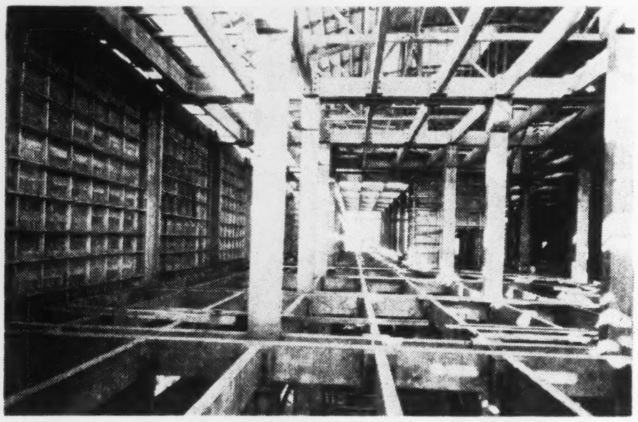

FIG. 5 CONNECTOR-BUILT HEAVY TIMBER MILL BUILDING DESIGNED FOR LOADING OF 400 PSF ON FIRST FLOOR AND 300 PSF ON SECOND AND THIRD FLOORS

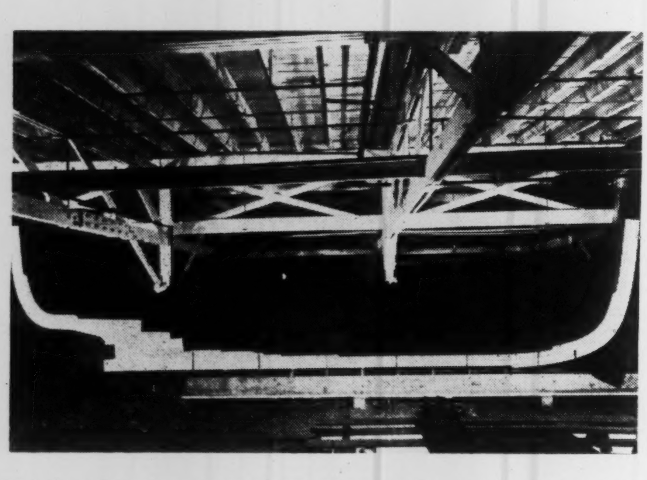

FIG. 4 ONE-PIECE GLUED-LAMINATED STEM, KEEL, AND STERN ASSEMBLY FOR 37-FT BOAT

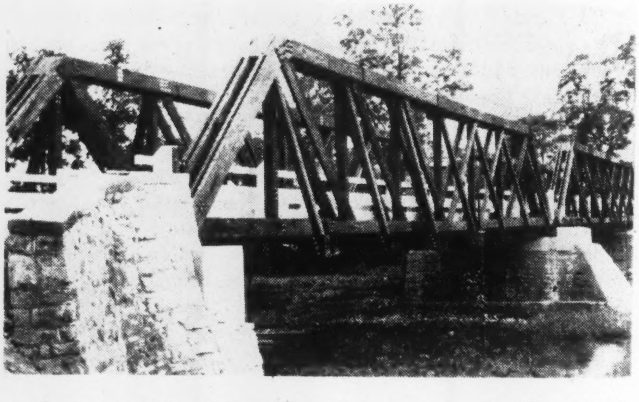

FIG. 6 CONNECTOR-BUILT HIGHWAY BRIDGE OF TWO 91-FT SPANS DESIGNED FOR H-20 LOADING

land initially logged is again ready for harvesting. This is but one of various means employed today to insure an ample future supply of wood. Forest experts realize today that true economy lies in maximum use of the land upon which the tree grows and of the tree itself when it reaches the proper size; not in letting the tree become overmature and deteriorate. It is just good sense to keep the land in production.

Under better forest management, determination of the size of tree which will realize the maximum annual revenue from investment is important. The optimum size or age depends upon the species of the tree, annual increment of growth, tax rates, market demands, and other factors. However, it is safe to say that on the average the size which proves most economical in the future will be smaller than has been the case in the past when virgin forest land was not at a premium and where little or no forest management was applied.

Even under the most advanced forest practices, it is impossible to grow trees without knots and grain distortions which influence the strength of the wood. Hence a large part of the bole of a tree is not best suited in its original form to uses which require high strength, such as important members of buildings, bridges, towers, and other load-carrying structures.

Through hundreds of thousands of tests conducted by the United States Forest Products Laboratory and other organiza-

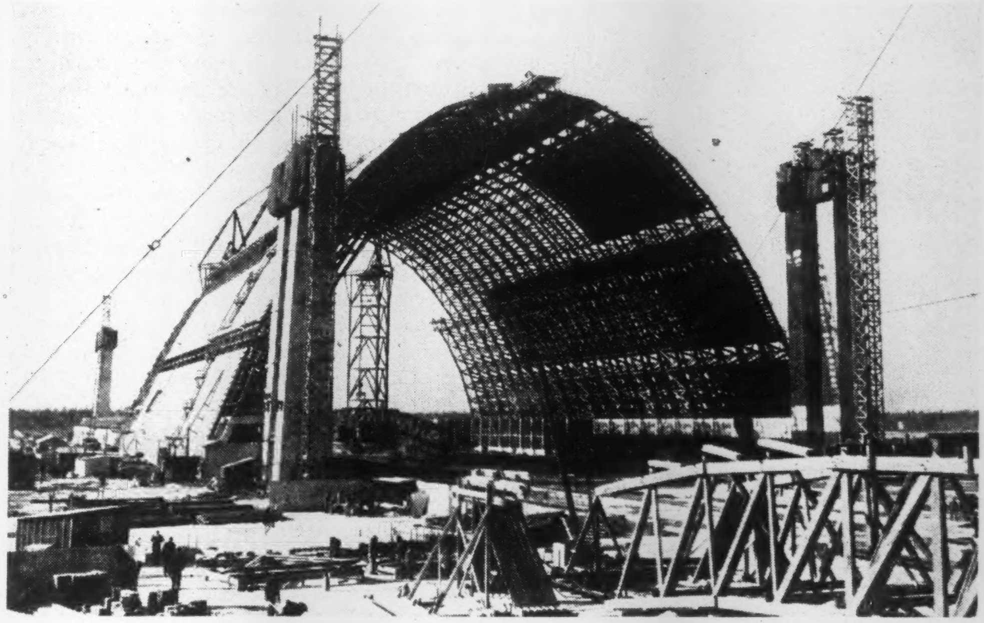

FIG. 7 ONE OF ABOUT TWENTY CONNECTOR-BUILT BLIMP HANGARS 296.5 FT WIDE, 170 FT HIGH, AND 1058 FT LONG

tions, the effect of tree characteristics on the various strengths and other use requirements have been well established and accurately evaluated. Commercial structural grades of lumber were formulated on the basic principles so determined.

Consequently, the load capacity per unit of wood in sawn timbers is increased greatly over that in the log by sawing the timbers from selected portions of the log and in such a way that the smaller knots and other minor characteristics allowed in a commercial structural grade have a minimum effect on the strength of the timber in its intended use. For example, in a beam, strength requirements are such that larger knots may be permitted at its neutral axis than at the top or bottom of its depth, and structural beams are so graded. Portions of the log with excessively large knots are resawn into smaller pieces of clearer material.

Peculiarly enough, large pieces of lumber are made from small pieces of lumber for the same reason that small ones are made from large. For large structures or even members carrying very heavy loads in small structures, it is generally more practical and economical to use an assembly of smaller pieces of lumber than to endeavor to obtain and use a very large single stick. This was not so true years ago when the connecting devices available for joining small timbers to make a large member or truss were not capable of developing a very high percentage of the strength of the wood. It is now possible to develop either through timber connectors or through glue the full strength of commercial lumber, thereby further upgrading lumber.

These two new developments in fastenings have in common the idea that the load-transferring devices should be at or near the surface of the lumber to avoid a substantial reduction in the effective cross section of the pieces joined. Since it is commercially impractical to produce great quantities of commercial lumber which is entirely clear and straight-grained, i.e., free from knots and other strength-influencing characteristics, the fastening which results in only a minor reduction in the effective cross section of the piece may still develop the full strength of the commercial piece of lumber.

Each of the two types of construction has its outstanding points and limitations. Since they supplement each other, they are frequently used together in the same structure. Taken together they provide very efficient economical wood construction for practically any job at hand.

TECO TIMBER-CONNECTOR CONSTRUCTION

Before discussing glued construction in detail, a brief description of connector construction is in order. This timber-connector system of construction was introduced into America from Europe by the National Committee on Wood Utilization and the U. S. Forest Products Laboratory, and has been sponsored by the National Lumber Manufacturers Association since 1933. Teco timber connectors are devices placed in the contacting faces overlapped members for the purpose of transferring load between the overlapped members. The connectors are either placed into precut daps or are forced into the timber by pressure. Connectors are of various forms and are designed for connecting wood to wood, wood to metal, and flat-sawn timbers to round piles or poles. Bolts passing through the timber connectors hold both the connectors and members in place. Teco timber connectors are efficient, make possible economical structures, and have been responsible for breaking many records for speed of erection.

Fig. 5 illustrates the construction of a connector-built heavy-timber mill building for a pulp-and-paper concern. It is designed for a first-floor loading of 400 psf and for second- and third-floor loadings of 300 psf.

Fig. 6 illustrates a connector-built highway bridge of two 91 ft spans with trusses designed for one-lane H-20 loading.

Fig. 7 illustrates one of about twenty connector-built hangars constructed to house blimps throughout the country. The exterior dimensions are 296.5 ft wide, more than 170 ft high, and 1058 ft long. The uninterrupted clear interior space is about 237 ft wide by 156 ft high by 1000 ft long.

To get some idea of the mammoth size of this structure, picture three football games being played simultaneously within it, or a fifteen-story apartment house erected beneath its roof.

The largest piece of timber used in these soaring arches is only 6 in. × 14 in. in cross section. Prefabricated hangars of this type have been assembled and erected at the average rate of 50 linear ft per 9-hr day, i.e., a complete hangar in only 20 one-shift days. Although these buildings house the largest uninterrupted space of any wood building to date, much larger hangars of a similar type are now under consideration.

DEVELOPMENT OF GLUED-LAMINATED CONSTRUCTION

In this country glued-laminated lumber construction was introduced into the structural field about 10 years ago. This

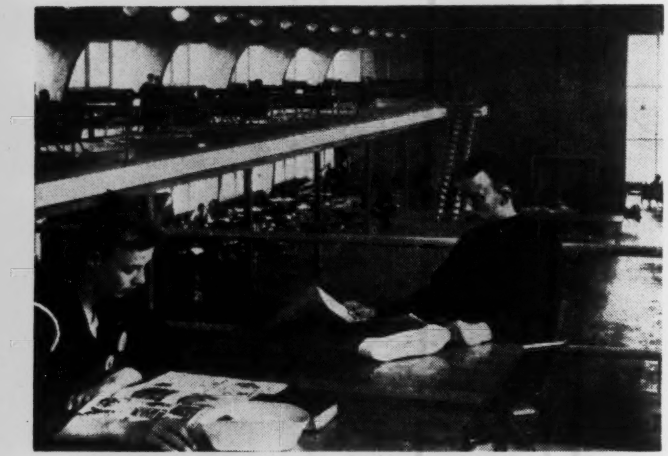

FIG. 8 GLUED-LAMINATED ARCHES OF 52-FT SPAN

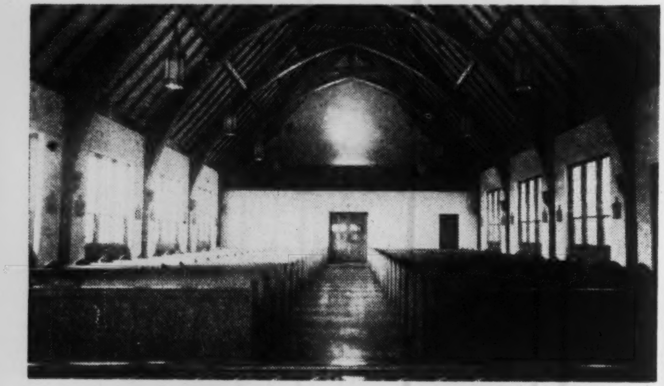

FIG. 9 GLUED-LAMINATED GOTHIC ARCHES IN CHURCH

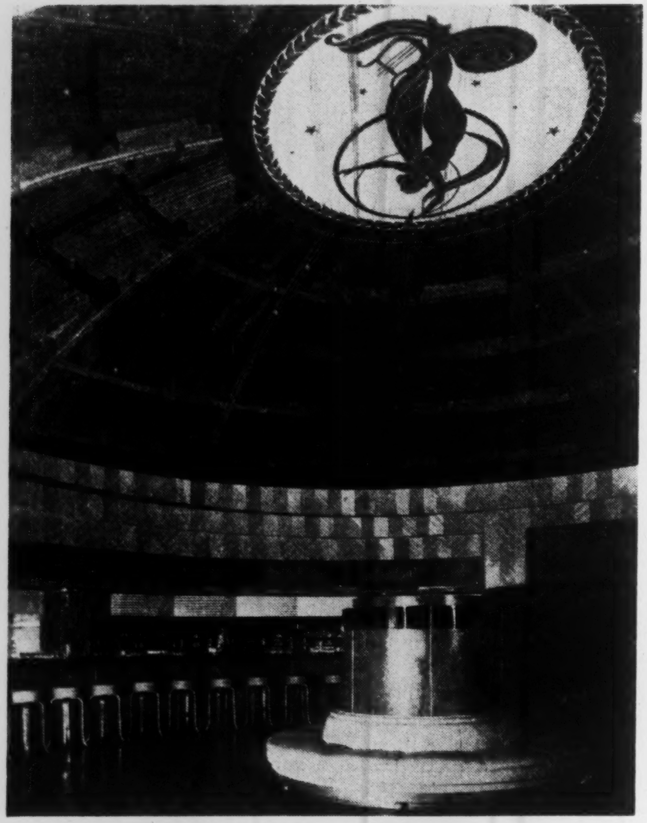

FIG. 10 GLUED-LAMINATED ARCHES FORMING DOME

construction has been used in Europe, particularly in Germany, Sweden, and Switzerland for nearly 40 years. Therefore it cannot be said that it is an untried form of construction. Even without the benefit of the greatly improved glues, more accurate lumber grading, extensive research, improved structural techniques, and practical experience available today, the older European laminated structures have given an excellent account of themselves. T. R. C. Wilson (1),[1] of the United States Forest Products Laboratory, who several years ago made a detailed study of about fifty European laminated structures, reported that his observations point to long life for laminated members in buildings. He stated: "Lack of examples of members that have failed or have seriously deteriorated under such exposure during the third of the century of the history of this type of construction precludes any but optimistic estimates of length of life and permanence."

In recent years, the United States Forest Products Laboratory and others have accumulated a formidable amount of test and other technical data leading to improved glues, improved fabricating procedures, and more accurate design of glued-laminated members. Therefore, present knowledge and experience should provide additional safeguards of strength and durability to this construction considered quite satisfactory even in the earlier stages of its development.

Modern commercial glues are designed to fulfill very rigid specifications. Practically all standard specifications for modern glues require that, when glued specimens are tested, more than one half of the broken area shall be a wood break, i.e., the glue must be as strong or stronger than the wood joined. WPB Directive 29, a national mandatory design directive and specifications for buildings (2), requires that, when the provisions of the specifications are applied, the designer shall assume that the glue lines in a glued-laminated member are as strong as the wood itself.

Although the various types of glues are intended for different uses and different degrees and kinds of exposure, glues are available today which will fulfill the requirements of practically any condition of service. For example, certain glues, designed for the purpose, show no signs of deterioration when repeatedly boiled and dried or submerged in fresh or salt water. Some show excellent resistance to various chemical fumes. Some are compatible with chemicals used in the various preservative, fireproofing, and other chemical treatments sometimes given wood.

Particular emphasis has been placed on the durability and strength of glued-laminated members when the proper glue for the service intended is selected and properly used, because apparently many people have the erroneous idea that construction glues are not strong and durable.

As for any other structure which is to perform a strength function, adequate knowledge of the materials used, proper design, and proper workmanship in fabrication are necessary for best results.

To insure the customer that the proper type of laminated lumber construction is selected for the use intended and that such selection will be properly manufactured, the glued-laminated lumber fabricators, glue manufacturers, lumbermen, and United States Forest Products Laboratory have recently initiated the formulation of national detailed technical standards. These standards will cover lumber, glue, gluing, fabricating practices, design, and performance standards for the finished product. As soon as the standards are established, inspection services assuring conformance to the standards will be made available. Hence, shortly, it will be possible to order a standardized product in glued-laminated construction for a particular use just as it is now possible to order a standardized high-speed machine drill with full assurance that the performance will be satisfactory.

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[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

ADVANTAGES AND ECONOMIES

Glued-laminated construction has many important advantages and economies in its favor.

Members can be built to any desired cross section, any length, or any shape. This permits the architect's fancy to run rampant in the realm of beautiful lines, shapes, and masses. Wood being an excellent base for waxes, stains, paints, and other forms of applied decoration, it permits the decorator to run the whole gamut of color schemes as well. Also, since the structural laminated members serve as an important part of the interior decoration, the expense of applying material to hide unsightly structural members is saved and the headroom is increased (see Figs. 8, 9 , and 10).

Members can be built from lumber which is too thin, too narrow, or too short to be structurally useful otherwise. Recently, a government official concerned with a large laminating program stated unofficially: "We find an increase of 20 per cent to 40 per cent in the use of the tree through use of laminated construction." In addition to permitting structural use of a larger portion of the tree, material of these smaller dimensions is more quickly dried or seasoned with less degrading from the seasoning process than would be the case for larger timbers comparable in size to the assembled laminated member.

Structurally the member can be tailor-made to fit the particular job to be done, i.e., the structural designer can specify the most economical shape and construction for carrying the load or otherwise serving the purpose intended (see Fig. 11). Members can be tapered in depth for greater strength, stiffness, and lightness as well as for more graceful appearance without appreciable waste of material (see Fig. 12). Low-grade material can be used in portions of the member where stresses are low and high-grade material reserved for portions having high stresses.

Glue is the strongest mechanical fastening for wood. Whereas glue can develop 100 per cent of the strength of clear, straight-grain lumber, when laminated parallel to the grain, the practical limit for other fastenings is about 85 per cent of the clear-wood strength. Therefore, it is possible to build up stronger lumber members of a given size by gluing than by any other means.

In addition to improving the structural properties of lumber by resawing to remove larger knots, the mere assembling of the lumber of a given grade tends to raise the structural qualities of the fabricated member above that of the grade from which it is made. Take a column or compression member as an example: A knot may occupy 20 per cent of the cross section of a single lamination when used by itself as a structural member. When this same lamination is assembled with nine other laminations, the same knot would occupy only 2 per cent of the cross section of the entire assembly. The probability that knots of any substantial area would occur in the other nine laminations at the same cross section is small but, even if knots equal in area to twice that of the maximum knot should occur at the same cross section, the maximum knot area would be only 4 per cent of the cross section of the whole member, compared with 20 per cent of that for the individual lamination. Hence the laminated member becomes much stronger relatively than the sum of the individual pieces of which it is made.

In the case of beams, the compression and tensile stresse resulting from bending are a maximum at the outer fibers at the top and bottom of a beam loaded vertically and are zero in the fibers at the neutral axis or mid-depth where horizontal shear is the maximum. Knots do not reduce and really increase the shear strength. So, theoretically, the knots could vary in size from approximately the full width of the piece at the neutral axis to clear, straight-grain wood at the top and bottom of the laminated member and give about the same strength as a beam with all laminations consisting of clear straight-grain wood. There are some other considerations which prevent this theoretical condition from being 100 per cent true in practice, but this upgrading effect does take place.

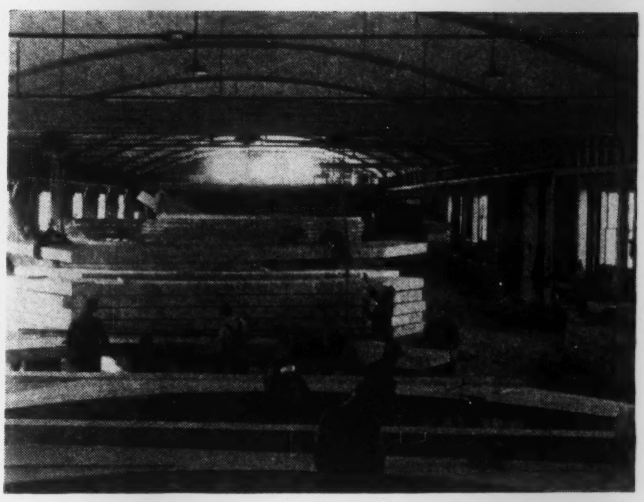

FIG. 11 SHOP SHOWING GLUED-LAMINATED ARCH ROOF, LAMINATED BEAM SUPPORTING TRAVELING CRANE, AND ARCHES BEING FABRICATED

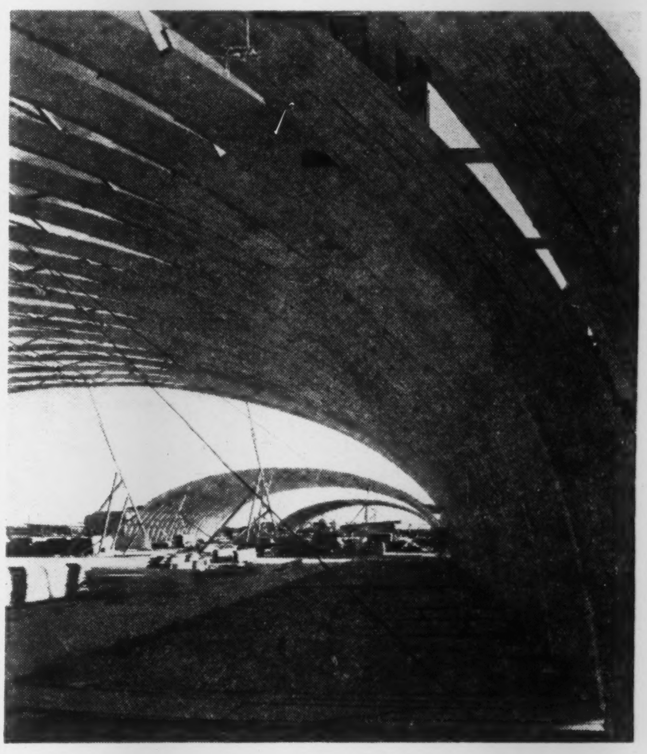

FIG. 12 TAPERED GLUED-LAMINATED ARCHES OF 151-FT, 6-IN. SPAN IN HANGARS

The large members possible in laminated construction afford excellent fire resistance. Heavy timber construction carries very low insurance rates, ordinarily much lower than unprotected steel and comparable to that of so-called fireproof concrete and masonry construction.

Availability and versatility are two important aspects of glued construction. Laminations are generally of nominal 1-in. and 2-in. lumber which are normally the most plentiful and widely available of all lumber thicknesses. Being relatively thin, such lumber can be bent into any curvature ordinarily desired. Material suitable for laminated construction may be selected from almost any grade. However, the best economy in construction which takes into account both cost of fabricating and materials may point to certain grades or range of grades.

LIMITATIONS OF GLUED CONSTRUCTION

Like all other construction, glued lamination has some limitations. One is, that square-cut butt-end gluing of lumber develops only about 25 per cent of the clear-wood parallel-to-grain strength. However, full strength is developed by side-grain gluing. Consequently, the end-gluing limitation is overcome by scarfing the ends, i.e., tapering the ends at a slope such as 1 in 12 to get, in effect, side-grain gluing. This scarfing involves some waste, particularly when many short pieces are assembled, but the resulting strength properties approach that of clear wood. The United States Forest Products Laboratory states in one of its technical bulletins (1):

"Tests on several species of wood have shown that a scarfed joint, if carefully prepared and well glued, has strength in tension or bending approximately as great as does the wood itself provided the length of the scarf is as much as 8 to 15 times the thickness of the material, depending on the kind of wood."

In general, for laminations of commercial lumber thicknesses, e.g., nominal 1-in. and 2-in. material commonly used, the laminations should be assembled so that the grain of all laminations is approximately parallel. If they are not so assembled and there is considerable change in the moisture content of the laminated member in service, differential stresses greater than can be resisted may be set up at or near the glue line between adjacent laminations. These differential stresses result from the fact that, with a substantial change in moisture content, wood changes dimensions appreciably perpendicular to grain but not parallel to grain. Therefore the adjacent laminations with grain at large angles to each other tend to expand and contract in different directions which in turn stresses the glue line.

However, this effect can be minimized in two ways. One is to reduce the thickness of lamination to the point where the total stress to be resisted in restraining movement at any one glue line is small. This is done with complete success in plywood construction.

For laminations of greater thickness, the effect can be reduced by using glue-contact areas of small dimensions so that the total dimensional change is small at any one contact area. This is done for glued built-up I or box girders with lumber flanges and plywood webs.

Even in assembling laminations with their grain parallel some manufacturers permit only all flat or all edge-grain stock in a member, i.e., flat-grain and edge-grain stock are not mixed in the same member. The reason for doing this is that the coefficient of expansion or shrinkage with moisture change is somewhat larger in the direction of a concentric circle around the tree than radially.

In laminating a structural member there is seldom any necessity for gluing adjacent laminations having the grain at wide angles. Members of practically any desired shape or curvature can be made by bending the individual laminations before assembling them and by trimming the assembled member.

In making up the framework of a large structure, connector joints nicely fill the gap when it comes to joining members at wide angles to each other, i.e., connector construction and glued-laminated construction supplement each other and are frequently used in combination. The bowstring truss is an outstanding example of economy so effected, Figs. 13 and 14. In this truss the arch or upper chord which closely follows the load polygon and carries the principal load is laminated, and the arch tie or lower chord and web members, which may or may not be laminated intersecting at wide angles, are connected to the arch by timber connectors.

The framework of the largest timber factory building in the world combines glued-laminated columns with connector-truss construction. The heavy construction used is illustrated in Fig. 15, whereas Fig. 16 gives a view of the completed structure. The laminated columns are about 45 ft high, the building is 830 ft wide and nearly 3000 ft long, i.e., this building is nearly three times as wide and three times as long as the blimp hangar previously mentioned.

COST OF GLUED-TIMBER CONSTRUCTION

With present material and price restrictions, current labor policies, and unsettled conditions generally, comparative prices or costs mean little during a war. In general, as its rapid growth prior to the war in direct open competition with other construction indicates, glued-laminated construction compares favorably in cost with other types. Comparison of cost piece for piece with solid lumber may show that solid lumber is somewhat lower in cost than glued-laminated members of the same size. It must be remembered that, for the glued-laminated member, it is possible to design the member for larger load-carrying capacity and to fabricate it more completely for its end use. Then it is worth more than solid lumber.

DESIGN OF STRUCTRUAL TIMBER

Recognizing that customary working stresses for structural lumber in engineered structures have been conservative to the point of wasting material, the War Production Board on August 8, 1943, issued a directive (2), which makes mandatory a 20 per cent increase in both customary working stresses for structural lumber and allowable loads for fastenings in buildings.

This specification, which contains complete fundamental design procedures for lumber and fastenings such as connectors, bolts, lag screws, spikes, nails, wood screws, and drift pins, also covers the design and construction of glued-laminated members. Although the same design formulas and procedures are applied to both solid- and glued-laminated-lumber members, in general, higher working stresses are specified for glued-laminated members than for the structural lumber from which the member is built. For example, allowable unit stress in compression parallel to grain, specified for a glued-laminated member, is 50 per cent higher (with an upper limit of 90 per cent of the allowable dry clear-wood stresses) than that for the individual pieces of structural lumber from which the laminated member is built.

In beams, lower-grade material is permitted in those portions of the member not highly stressed without any reduction in working stresses for the laminated member as a whole. More complete design information is given in this directive (2) and its accompanying specification.

Fear had been expressed by some engineers that the stresses induced by bending laminations to form curved members, such as arches, might reduce the working stresses to a point where this construction would be impractical. However, through extensive testing, the United States Forest Products Laboratory found this fear to be groundless. The tests showed that, for the most part, the stresses induced by bending dissipated themselves during the time required for the glue to set sufficiently to permit mechanical testing of the laminated member. The tests showed the strength of a curved member to be

$$[1.00 - 2000\,(t/R)^2]$$

times that of a straight member where t is the thickness of lamination and R is the radius of curvature in inches.

An example will illustrate the importance of this discovery. Assuming an allowable unit working stress f of 2000 psi, a modulus of elasticity E of 1,600,000, a thickness of lamination t of 1 in., and a radius of curvature R of 400 in. (33 ft 4 in.), and applying the standard formula of engineering mechanics for stresses induced by bending a rectangular section $\left(f = \frac{Et}{2R}\right)$, it is found that 100 per cent of the allowable working stress of 2000 psi would be used up merely by the bending of the lamination to the

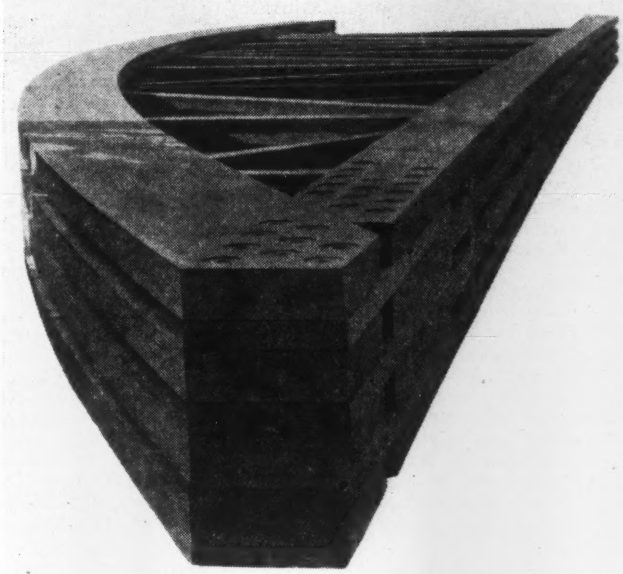

FIG. 13 CLOSE-UP OF 140-FT BOWSTRING TRUSS WITH GLUED-LAMINATED TOP AND BOTTOM CHORDS JOINED BY CONNECTORS FOR AIRCRAFT FACTORY

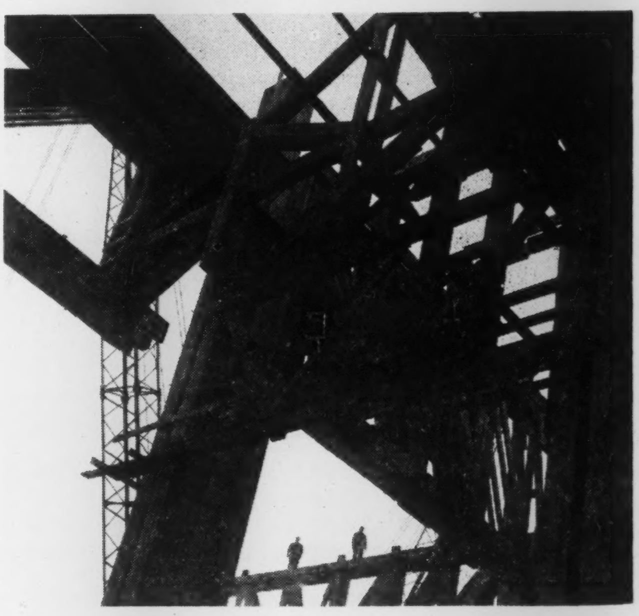

FIG. 15 CLOSE-UP OF FRAMEWORK IN AIRCRAFT ASSEMBLY PLANT SHOWING GLUED-LAMINATED COLUMNS AND CONNECTOR-BUILT TRUSSES

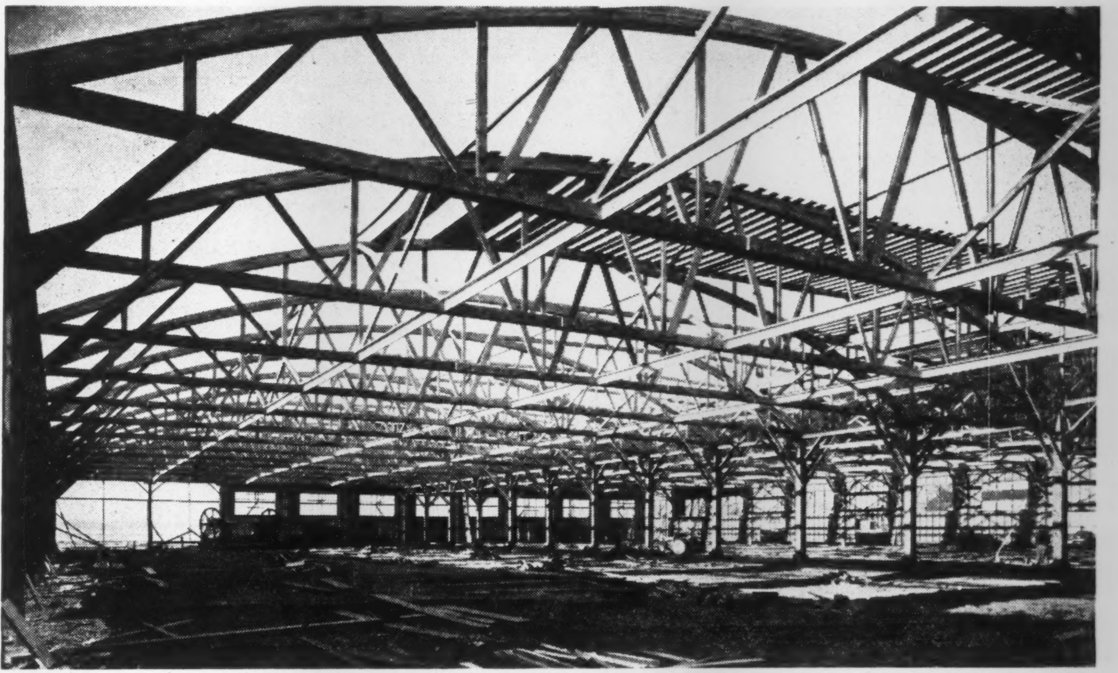

FIG. 14 INTERIOR VIEW OF BOWSTRING TRUSSES OF 26- TO 105-FT SPANS IN PLYWOOD FACTORY

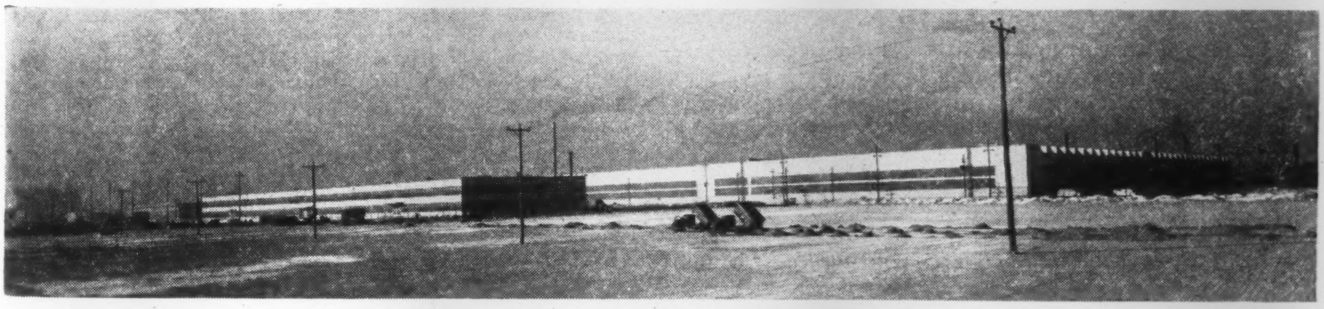

FIG. 16 WORLD'S LARGEST TIMBER FACTORY BUILDING, 830 FT WIDE BY 3000 FT LONG, COMBINING GLUED-LAMINATED COLUMNS WITH CONNECTOR-BUILT TRUSSES

400-in. radius. However, application of the formula derived from actual tests, instead of the theoretical formula, indicates that the actual reduction in load-carrying capacity of the member is only $1^{1}/_{4}$ per cent instead of 100 per cent, i.e., a working stress of 1975 psi instead of 0 psi is available to resist applied loads.

METHODS OF FABRICATION

Although fabrication details will vary somewhat with the individual fabricator and glue, the general procedure is as follows:

Nominal 1-in. or 2-in. lumber is seasoned to the desired moisture content. This is generally about 10 or 12 per cent but may be from 8 to 18 per cent depending upon service intended and individual shop preferences. However, all lumber should be seasoned within about 2 per cent of the moisture content selected to avoid differential dimensional change of individual laminations after lamination.

If end joints are to be scarfed, the scarfs are cut, and enough pieces are glued together end to end to form a length of lamination equal to the full length required for the member prior to assembly of laminations into the member. Each lamination is surfaced smooth to remove excess glue, to insure that the scarf and the remainder of lamination are of uniform thickness throughout its length, and to provide a clean flat gluing surface.

Likewise, if the width of lamination is to be built up by edge-gluing two or more pieces together, this operation is completed prior to the assembling of the laminations.

The lamination is run through a glue spreader (rollers which spread glue uniformly on the surface) and is then placed on a table with dogs or on jacks or chairs (forms) arranged to give the desired shape of member. The various laminations are assembled quickly and the required pressure applied through clamps or jacks.

The laminations are held under pressure, generally from 100 to 200 psi, until the glue has set sufficiently to permit handling without deleterious effects on the glue line, generally 4 to 8 hr, depending upon temperature of materials and other factors. With some glues, requiring higher than room temperatures for setting, the member is heated in a kiln or otherwise.

The assembled member is removed from the table or chairs, and the glue is allowed to set sufficiently to permit trimming and planing of the surfaces to the desired smoothness or finish for the use intended. When the glue is fully set, generally several days after assembly, the member is transported to the site and incorporated in the structure.

Sometimes preservative, fireproofing, and surface treatments are applied either before or after gluing the laminations together, depending upon the compatibility of the glue and various chemicals used.

The foregoing processes are simple in themselves but call for adequate knowledge of each step taken. For best results, the moisture variation in the lumber must be small. The glue must be mixed in the right proportions and must be applied while still possessing the proper consistency or life. The temperature of the materials must be correct. The surface of the wood must be smooth but not dirty or greasy. The glue must be spread uniformly and in the proper thickness. The pressure must be applied while the glue is still tacky, must be adequate but not too great, and must be held for the proper length of time. The specific limitations within which each step must be accomplished varies with factors, such as type of glue, moisture content of wood, temperature of materials, and others.

CONCLUSIONS

Industrial executives planning expansion should thoroughly investigate the possible use of glued-laminated construction. It has reached a stage of development that, when well fabricated with proper materials, there can be no doubt as to its adequacy and dependability.

Glued-laminated lumber construction has grown up.

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Railroad Equipment in Wartime

(Continued from page 864)

one 70-ton gondolas, one 50- and one 70-ton hopper car, and one 50- and one 70-ton flat car.

Emergency drawings for two composite boxcars have been prepared, but the A.A.R. committee points out the difficulty of maintaining such cars.

Designs for troop coaches, troop sleepers, and command, and kitchen cars have been prepared and put into construction. These are based on the A.A.R. standard 50 ft 6 in. steel-sheathed boxcar and the framing can be used for such cars when troop movements are at an end.

SOME PREDICTIONS

In trying to look into the future, I can do no better than call attention to some bold predictions made at the joint meeting of the A.S.M.E. and the Pacific Railway Club in Los Angeles on June 15, 1943, by Morris P. Taylor, assistant mechanical engineer of the Southern Pacific Company.

Mr. Taylor called attention to a possible shift in the relative supply of coal and oil for fuel and to the increased amount of cheap electric power that may be available. There are factors that may affect seriously the availability of the various forms of motive power.

Dealing with locomotives and cars, Mr. Taylor listed many possible developments. Some of these are already taking shape. In the case of the steam locomotive, careful consideration is being given to developments which will maintain its fundamental advantages and obtain higher efficiency and still greater usefulness.

Higher steam pressures and temperatures to obtain better thermal efficiency are in the offing. The present top pressure of 300 psi is about the maximum that can be carried with the conventional type of fire-tube locomotive boiler. Water-tube boilers for pressures up to 600 or 800 psi are already on drawing boards and promise the advantages of lighter weight and greater safety.

The opportunities offered by this better steam will be taken advantage of by better utilization of the steam in cylinders or in turbines. These things are definitely approaching.

A possibility also to be considered is the combustion-gas turbine locomotive, one of which has been built in Switzerland. Still further over the horizon is the possibility of a combined steam-and-mercury-turbine locomotive which would cut water consumption in half and greatly reduce the fuel cost. These things may be termed visionary at present, but we have it on the highest authority that "without vision, the spirit perisheth."

PSYCHOLOGICAL CASUALTIES[1]

By PAUL PIGORS

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IN the First Service Area, about 6000 soldiers a week are being returned from army camps and active duty. As a result of injuries, illness, and other disabilities, they have been declared unfit for combat duty. They are being released for civilian life. A large majority of these men are psychological casualties. They have gone to pieces under the terrific strain of modern warfare and the rigorous training called for to meet present service requirements. They are neurotic, that is, literally unable for the time being to "pull themselves together" and meet adult responsibilities as integrated personalities. They are unhappy, restless, and easily discouraged. In this frame of mind it is well nigh impossible for them unaided to make the necessary adjustments required by a return to "normal" life.

This type of war casualty deserves and must receive all the help that we can give them. Since they are not outwardly crippled it is easy to loose track of them as soon as they are out of uniform. Of course there are the provisions of the United States Army Reserve and Retirement Personal Service Law of 1940, Chapter 689, 54th Statute, providing for the reemployment of former employees who return under the Law from the armed forces. This is satisfactory for "normal" people but does not meet the requirements of psychological casualties who find both themselves and the situation changed. The gap thus created is too wide to be easily bridged. Company officials may expect them to step easily across the line into civilian life whereas actually they need help in getting from one kind of world into another.

Periodically, newspapers feature the case of a returning serviceman who has been unable to find a job and feels himself lost in an industrial society that seems utterly indifferent to his economic and social needs. Several such cases have been carefully checked by the War Manpower Commission and it was found that the individuals in question had been offered a large number of jobs (22 in one instance). However, these particular exservicemen made such exaggerated demands and understood their own situation so little that satisfactory routine placement was impossible. Only skillful counseling could have enabled them to make the necessary mental and social readjustment.

At present the psychological casualties are comparatively few in number, but they will certainly be greatly multiplied when demobilization comes. Industrial leaders cannot wait until after the war to develop plans and techniques for meeting the responsibility created by these exservicemen. Fortunately, we have at hand the key to this problem—counseling. However, as far as industry is concerned this technique is as yet inadequately understood. In acquiring greater understanding and proficiency, personnel men have much to learn from an outstanding authority in the field of psychotherapy, Prof. Carl R. Rogers, whose book,[2] "Counseling and Psychotherapy: Newer Concepts of Practice," is a "must" on every industrial-relations bookshelf.

This book deals primarily with the process of counseling, and grew out of Professor Rogers' extensive practical experience and theoretical background. It provides a systematic framework for our understanding of newer counseling techniques and is amply illustrated by analyzed examples. The author shows why the older methods of "counseling" have fallen into disrepute. For instance, the previously accepted methods of ordering and forbidding, exhortation, persuasion, and intellectualized interpretation fail to reach the heart of the matter. Thus, the method of exhortation is described as an attempt to "create a temporary emotional upsurge and then trying to 'peg' the individual at that high level of good intention." Unfortunately, experience teaches that pledges and promises seldom bring about real change and are usually followed by quick relapse.

All these techniques have in common the erroneous assumptions that: (1) The counselor knows best how to assess the values and choose the goals by which the adjustment situation is to be determined; (2) the counselor can himself work out common-sense techniques to bring the client most efficiently to the goals selected by the counselor. Both these assumptions imply a mechanical determinism and disregard the individual's central need, the development or recovery of powers to help himself.

In modern counseling, "the individual and not the problem is the focus." The counselor's aim is not to solve any particular problem but to help the individual become more self-reliant in coping with this and other difficulties. If he can gain enough integration to handle one problem by himself he will then be on the right track toward taking charge of his own life.

The author gives a tentative list of criteria which indicate when counseling can successfully be used. All these apply to the problem of the returning exservicemen. He also gives an illuminating discussion of the basic aspects of a sound counseling relationship. He asks and answers such questions as:

How should the counselor meet the problem of his own emotion involvement in the counseling relationship?

Should he allow the counselee free expression of all his undesirable feelings?

What are advisable limits for the counselor to establish?

To what extent should the counselor take responsibility for the problem and action of the counselee?

One of the most important contributions of the book is a carefully annotated case study based on phonographic records of interviews. From this, the industrial counselor can check and improve his own techniques. It is by such study that the personnel man can prepare himself while there is yet time, adequately to meet the needs of psychological casualties who must be helped to make a satisfactory readjustment, if industrial leaders are to meet the responsibilities that are an integral part of their power and position in an industrial society.

A training manual, "On-the-Job Instruction of Screw-Machine Personnel," prepared by the National Screw Machine Products Association, presents easily understood instructional material in an original manner and covering all types of multiple-spindle automatics. In addition to functional machine operation, the manual includes extensive data on grinding and setting tools and comprehensive "trouble" charts. The 14 Brown and Sharpe training pamphlets are also cross-indexed in the manual. It is a 107-page book, with oil-resistant cover and plastic ring binding. Copies may be purchased by writing to the Association, 13210 Shaker Square, Cleveland 20, Ohio.

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[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Counseling and Psychotherapy: Newer Concepts of Practice," by Carl R. Rogers, Houghton Mifflin Company, 1942, 445 + 16 pp., bibliography.

E.C.P.D. *in the* WAR

Eleventh Annual Meeting of the Engineers' Council for Professional Development—Interest and Programs Keenly Alive

WAR and postwar problems and their effects on engineering education were the major topics discussed in committee reports and at the dinner held in connection with the eleventh annual meeting of the Engineers' Council for Professional Development, New York, N. Y., October 23, 1943.

The morning session of the Council was devoted to routine business of electing officers, appointment of committee members, adoption of the budget for 1943–1944, and the reports of committees, including the report of the chairman, Robert E. Doherty, president, Carnegie Institute of Technology, and president, Society for the Promotion of Engineering Education, who retired after three years of service as chairman of the Council.

EVERETT S. LEE ELECTED CHAIRMAN

The Council elected as its chairman for next year Everett S. Lee, of the General Engineering Laboratory, General Electric Company, Schenectady, N. Y.; as its vice-chairman, James W. Parker, past-president A.S.M.E., vice-president, The Detroit Edison Company, Detroit, Mich.; as its secretary, S. L. Tyler, secretary, American Institute of Chemical Engineers, New York, N. Y.; and as its assistant secretary, Robert L. Sackett, fellow A.S.M.E., dean-emeritus of engineering, Pennsylvania State College.

Chairman of the four major committees of E.C.P.D. were elected as follows:

Committee on Student Selection and Guidance, A. R. Cullimore, member A.S.M.E., president, Newark College of Engineering, Newark, N. J.

Committee on Engineering Schools, D. B. Prentice, member A.S.M.E., president, Rose Polytechnic Institute, Terre Haute, Ind.

Committee on Professional Training, John C. Arnell, manager, Personnel Co-ordination Bureau, Consolidated Edison Company of New York, Inc., New York, N. Y.

Committee on Professional Recognition, Chas. F. Scott, member A.S.M.E., emeritus professor of electrical engineering, Yale University.

Announcement was made of the appointment, as one of the A.S.M.E. representatives on E.C.P.D., of Ralph L. Goetzenberger, to replace A. R. Stevenson, Jr., whose term of office expires in 1943. Other A.S.M.E. representatives on E.C.P.D. are James W. Parker and Robert L. Sackett. Mr. Goetzenberger was also elected to serve on the executive committee of E.C.P.D.

I CHAIRMAN DOHERTY'S REPORT

In view of the fact that the principal features and recommendations of E.C.P.D. committees were summarized by Chairman Doherty, his report to the Council is presented in full, as follows:

In my report[1] to the Council last year I urged that although the war would necessarily interfere with certain of its activities, it should, nevertheless, take an aggressive position. There was every reason for pursuing actively those projects with which the war need not interfere and in which an interruption of activity would involve destructive results in the long run. Moreover, the war brought new problems, especially in the field of the Committee on Engineering Schools but also in connection with the supply of professional engineering manpower, which seemed to require the Council's consideration.

May I also remind you of two other matters of long-range policy, discussed in that report and approved by the Council, which the chairman had regarded as prerequisite to achieving the objectives outlined in the Charter. One was the cultivation among the constituent bodies of an attitude of co-operation and an improved practical facility in taking joint action. There was, of course, no thought of joint action on matters outside the scope of E.C.P.D., or even on untimely matters within that scope. Simply, learning how to co-operate in activities directed toward E.C.P.D. objectives would presumably make it easier to co-operate in others. If so, an advance would be made in professional development. The other purpose was an educational campaign. The objectives of E.C.P.D. could never be achieved if only the members of the Council—or perhaps even only the members of the executive committee—knew what E.C.P.D. was and what it was trying to do. Individual engineers must know and be interested in these activities. I can assure you that the officers of the Council and the chairmen of the committees have been active in carrying out these directives that have been approved during the past two years.

POINTS OF POLICY URGED

Before commenting upon the work of the Council, I wish to urge three further points of policy.

During my six years on the Council and three as chairman I have become keenly aware that if the Council is to endure and accomplish the purposes for which it was organized, certain principles must be recognized; otherwise the centrifugal forces that have broken other co-operative enterprises in the engineering profession might also break E.C.P.D. It early became clear that we must remove unnecessary internal pressures, which were largely centered upon misunderstandings and matters of detail, and address the attention and energies of the Council to its constructive business. In the second place, it became clear also that a distorted conception of purpose must be cleared up. The Council's business is defined with reasonable clarity in the charter and is represented by the four standing committees. The growing tendency to regard the work of accrediting curricula as the primary and perhaps the only significant purpose was ill advised; the objectives represented by these four committees were *all of them* of great fundamental importance. And finally, and above all, it became clear that the Council should stick to its business and not yield to the pressures which are constantly arising for it to interest itself in matters outside, or at the fringe of, its purview. If the Council sticks to its purposes as now defined until it reasonably accomplishes them, it will avoid disruptive pressures and will also, I hope, have demonstrated to the constituent bodies that they may with assurance delegate other activities to it if the future should bring new problems that require joint action of a character which the Council could appropriately handle. That time is of course at some distance from us now. Here, then, are three points: We must remove unnecessary internal pressure, not permit purpose to become distorted, and stick to our business. In retiring from the chairmanship this year, I strongly commend these points to the Council's perennial consideration.

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[1] See Mechanical Engineering, December, 1942, p. 894.

THE "FAIRMAN PLAN"

Our work has gone forward. One result is improved machinery for doing business. It has seemed clear that neither an educational campaign nor other activities that must be pursued "at the level of the individual" in order to be effective could be carried out without the establishment of new machinery or rather the supplying of new links between parts of existing machinery. During the past two years there has been continued study of this problem and discussion of it from time to time in meetings of the Executive Committee. At the last Council meeting a plan drafted by J. F. Fairman, chairman of a special committee on this matter, had reached a stage where the Council approved it in principle and authorized him to seek approval of the boards of the constituent organizations. I am happy to report that this carefully constructed plan has been approved by the constituent organizations and thus the machinery is created for carrying forward our work at the level of the individual engineer and engineering student. On behalf of the Council I express deep appreciation of the constructive work which Mr. Fairman has done.

CONSULTATIVE COMMITTEE OF W.M.C.

The Council has concerned itself indirectly with the problem of professional engineering manpower in the war effort. Since E.C.P.D. itself was not, by its Charter, in position to deal effectively with this urgent problem without elaborate procedures of approval, the Chairman approached it in a way to obtain prompt action, to keep the Council's interest, but not to involve its direct responsibility. Last year I reported upon the establishment, under the initiative of the officers of E.C.P.D. and after consultation with the secretaries of engineering bodies concerned, of the Consultative Committee on Engineering of the then Division of Professional and Technical Employment and Training of the War Manpower Commission, of which President E. C. Elliott was head. This committee was to be a body to which President Elliott's division could turn for counsel in connection with problems of engineering manpower in the war effort, or which could, on its own initiative submit recommendations on behalf of the engineering profession. The committee proceeded promptly to deal with President Elliott, whose purview at that time encompassed substantially all matters of engineering manpower in the war effort, and with whom the committee's recommendations had great weight. Then, before significant results were accomplished, unfortunate changes occurred in the War Manpower Commission. After "Employment" was taken out of the division referred to and later after the resignation of President Elliott and also in view of the fact that the several engineering societies were independently sending recommendations to government agencies concerning professional engineering manpower, it was clear to the Consultative Committee that its status was confused and ineffective and that a clarification should be sought if the committee was to continue. The committee took action to this end on May 18, 1943, and requested on the one side that the boards of the engineering societies concerned authorize the committee to make recommendations in their behalf with the understanding that no recommendation would be made that did not have the unanimous approval of the societies concerned; and on the other side, that the War Manpower Commission change the status of the committee so that it would report not to a division or bureau representing only one phase of the general problem of engineering manpower in the war effort, but to an office whose purview would encompass any matters about which the committee was likely to have a recommendation. At long last I am now in position to report that on the engineering side the proposal has been approved by the boards of the A.I.E.E., A.S.M.E., A.I.M.E., A.I.Ch.E., I.R.E., and S.P.E.E. The A.S.C.E. and S.A.E. have not approved. On the side of the War Manpower Commission I am pleased to report that I received only this week a letter notifying me informally that agreement had been reached as to the status of the Consultative Committee on Engineering and that it would report to the chairman of the W.M.C. Committee on Professional and Technical Personnel and Service (a committee to co-ordinate the work of the several agencies within the W.M.C. in connection with these matters); also that I would receive formal notification within a few days from the Office of the Executive Director of the W.M.C. Thus the machinery is established for effective communication of counsel from the engineering profession to the War Manpower Commission in connection with problems of professional engineering manpower in the war effort.

WORK ON STUDENT SELECTION TESTS

Another important development is the tripartite plan involving the Society for the Promotion of Engineering Education and the Carnegie Foundation for the Advancement of Teaching in connection with selective tests. In an earlier report I suggested that student selection is one of the most important of the Council's problems, as indeed it is also of the engineering colleges, and that the maximum possible encouragement should be given to the work of our Committee on Student Selection and Guidance, for which Dean Sackett over many years and without adequate financial resources laid the foundation. You will recall that the Council last year allocated $2692.18 to the work of that committee. The tripartite plan involves a financial arrangement in which the Carnegie Foundation will pay $15,000, the E.C.P.D. $3000, and the S.P.E.E. a small contribution (in addition to its annual $500 appropriation to E.C.P.D.) as may later appear necessary and be approved by the S.P.E.E. It is the hope of the chairman of the Council and the chairman of the Committee on Student Selection and Guidance that the Council will see fit to include in the budget for 1943-1944 at least an amount equal to the difference between the $2,692.18 and the total commitment of $3000. Otherwise these chairmen will be obliged to join the sponsors and thus have a "quinpartite" plan! So much for the finances. Although President Cullimore, now chairman of the committee, will outline the work in detail, I would at least say that the work includes the design of tests to determine the probability that a prospective student will satisfactorily complete an engineering curriculum, and a plan to determine the validity of such tests at certain representative institutions. The officers of the Council are gratified at the progress of this work and regard it as one of the most constructive enterprises which the Council has engaged upon. And the co-ordinated effort with these other two agencies assures a sympathetic interest on the part of engineering educators, and reliability and professional recognition of the tests themselves.

MANUAL FOR JUNIOR ENGINEERS

Another project which the Council definitely authorized last year, including the approval of an initial appropriation of $2200, was the "Manual for Junior Engineers" planned by the Committee on Professional Training, of which Everett S. Lee is chairman. It has been most gratifying to see this work go forward with enthusiasm and thoroughness in spite of the handicaps that war pressures have interposed. Mr. Lee's report outlines progress in detail.

COMMITTEE ON ENGINEERING SCHOOLS

I have already referred to the wartime problems in the field of the Committee on Engineering Schools, of which President Donald B. Prentice is chairman. I am sure you will heartily approve the stand which this committee has taken with respect to the maintenance of standards in admission, graduation, and teaching; and also the vigorous way in which it has moved ahead in its study of the problem of the technical institute under the subcommittee leadership of Dean H. P. Hammond. The chairman's report also indicates in a very modest manner the assistance which the machinery and some of the personnel of his committee have rendered to the Armed Forces.

PROFESSIONAL RECOGNITION

The Committee on Professional Recognition has followed with unremitting energy its policy to continue an educational campaign among the new generation of engineers that would lead ultimately toward the end of "greater solidarity of the profession." I dare say that there are few young engineers and engineering students on whom the force of Professor Scott's crusade has not had an effect. His committee is carrying out its purpose largely by the distribution of appropriate articles, such as Dr. Wickenden's "Second Mile," and now plans are being framed jointly between the E.C.P.D. Committee on Professional Recognition and the S.P.E.E. Committee on Personal Development, of which Dean Ivan C. Crawford is chairman, to give even greater emphasis to the enterprise.

COMMITTEE ON INFORMATION

The Committee on Information under the chairmanship of Edward H. Robie has been most helpful during the year in connection with difficult questions in which the experience of the members of this committee places them in position to judge wisely. It is my opinion that the experience and talents represented on this committee have not been as fully utilized as might be in the best interests of the Council. And I therefore recommend an increasing interest in the help they are in position to give the Council without, I think, undue additional burdens on the committee members.

PRINCIPLES OF ENGINEERING ETHICS

And finally, I come to the Committee on the Principles of Engineering Ethics. I need not remind you that Professor Jackson and his committee have had a most difficult assignment, and I am sure that although a final report has not yet emerged which could receive the approval of all the constituent bodies, the committee's work has come a long way toward clarifying the issues involved, and I confidently hope that further consideration by the committee and by the constituent members of the Council will in due course bring the results we have long wished for, namely, a set of principles of engineering ethics that is acceptable to the profession as a whole.

THE ENGINEERING FOUNDATION'S AID

The extensive work of the Council which I have outlined was made possible in a large measure by the very substantial appropriation of The Engineering Foundation, and I wish to express here the Council's warm appreciation of the Foundation's confidence and interest and to say that it is our hope that the results being accomplished by our several committees will afford the Foundation satisfaction and give it good reason for continued support of the work.

In this, my final report as chairman, I wish to say that it has given me great satisfaction to work with my colleagues toward the important end of strengthening the Council's position. I hope that it is stronger both financially and structurally and that its purposes are better understood. And I take this occasion to record my appreciation of the support which the constituent bodies have given the Council and of the enthusiastic way in which the several committees have gone forward with their work.

II THE COMMITTEE REPORTS

In the reports of E.C.P.D. Committees submitted by their chairmen or other representatives, a few points, not covered in President Doherty's report, are worthy of mention. The complete texts of these reports will be published and distributed by E.C.P.D. some time in the near future.

STUDENT SELECTION AND GUIDANCE

In reporting for the Committe on Student Selection and Guidance, its chairman, Allan R. Cullimore, member A.S.M.E. and president of the Newark College of Engineering, Newark, N. J., said that the committee had continued the work carried on for the past ten years under the chairmanship of Robert L. Sackett, fellow A.S.M.E. There were two principal phases of this work, he said, first the counseling of high-school students, which had been carried on with great success in the metropolitan area with the fullest co-operation of the Board of Education of the City of New York; and second, the study of educational measurements, mentioned by President Doherty, in which the Carnegie Institute for the Advancement of Teaching was cooperating, not only by giving financial aid but by making available the services of a member of their staff, Dr. Kenneth Vaughn.

WAR CONDITIONS IN THE SCHOOLS

D. B. Prentice, member A.S.M.E., chairman of the Committee on Engineering Schools, which, for several years, has successfully accomplished the task of accrediting engineering curricula, said that the committee's work in this area had naturally been greatly curtailed as a result of war conditions.

"The Committee on Engineering Schools," he said, "is fully aware of the problems confronting technological schools now and the difficulties to be faced in the postwar years. It is taking every precaution it believes feasible to help engineering colleges to maintain and protect scholastic standards. By correspondence it advises with many engineering-college administrators in regard to proposed emergency measures necessitated by the war.

"It is co-operating with other committees of E.C.P.D. and elsewhere, whenever it can be of assistance in promoting efforts of importance to engineering schools and students.

"At least five of its members are spending full or part time in Washington in special wartime service for the government.

"And finally, its subcommittee on Technical Institutes, in spite of personal war responsibilities, is studying with special care the whole field of technical training and in due course will present a comprehensive report."

President Prentice also announced that the committee considered the Navy's full eight-term specialized curriculum as meeting the requirements for an engineering degree.

PROFESSIONAL TRAINING

Amplifying what Chairman Doherty had said about the Committee on Professional Training, Everett S. Lee, chairman, announced that W. A. Wickenden, member A.S.M.E., and president, Case School of Applied Science, had agreed to write the text of the proposed "Manual for Junior Engineers."

The junior reading list, prepared several years ago by the committee, was to be revised, he said.

PROFESSIONAL RECOGNITION

C. F. Scott, for the Committee on Professional Recognition, placed great stress on the opportunities facing teachers of engineering students to arouse in them professional consciousness and announced that steps were being taken by President Doherty, by the committee itself, and by S.P.E.E. to urge teachers to make the most of these opportunities. He paid tribute to the late Conrad N. Lauer, past-president A.S.M.E., for what he had done in laying the groundwork for E.C.P.D. He also outlined many suggestions of ways of assisting furtherance of the Fairman plan, "How to Help."

ENGINEERING ETHICS

D. C. Jackson, fellow A.S.M.E., chairman of the Committee on Engineering Ethics, amplified what Chairman Doherty had reported on the work of his committee and the status of the

"Canons of Ethics." He also presented a statement, "Faith of the Engineer," which was not to be considered as an oath or specification but a means of stimulation and encouragement. This statement was approved by the Council without implications as to its use. The statement, originally prepared by A. B. Parsons, secretary, American Institute of Mining and Metallurgical Engineers and slightly modified by the committee, follows:

FAITH OF THE ENGINEER

"I am an Engineer. In my profession I take deep pride, but without vain glory; to it I owe solemn obligations that I am eager to fulfill.

"As an Engineer, I will participate in none but honest enterprise. To him that has engaged my services, as employer or client, I will give the utmost of performance and fidelity.

"When needed, my skill and knowledge shall be given without reservation for the public good. From special capacity springs the obligation to use it well in the service of humanity; and I accept the challenge that this implies.

"Jealous of the high repute of my calling, I will strive to protect the interests and the good name of any engineer that I know to be deserving; but I will not shrink, should duty dictate, from disclosing the truth regarding anyone that, by unscrupulous act, has shown himself unworthy of the profession.

"Since the Age of Stone, human progress has been conditioned by the genius of my professional forebears. By them have been rendered usable to mankind Nature's vast resources of material and energy. By them have been vitalized and turned to practical account the principles of science and the revelations of technology. Except for this heritage of accumulated experience, my efforts would be feeble. I dedicate myself to the dissemination of engineering knowledge, and, especially, to the instruction of younger members of my profession in all its arts and traditions.

"To my fellows I pledge, in the same full measure I ask of them, integrity and fair-dealing, tolerance and respect, and devotion to the standards and the dignity of our profession; with the consciousness, always, that our special expertness carries with it the obligation to serve the public and humanity with complete sincerity."

FAIRMAN PLAN

J. F. Fairman, assistant vice-president, Consolidated Edison Company of New York, Inc., author of the Fairman plan referred to by Chairman Doherty, reported that the plan had been developed to a point where the text of a pamphlet, "Will You Help?" mentioned by Professor Scott, was ready to be printed. The pamphlet describes "an opportunity and a plan for local chapters, sections, and branches of the eight participating bodies" of E.C.P.D., "and other local engineering organizations and interested groups," to assist in practical cooperation for the furtherance of the objectives of E.C.P.D.

THE UNION QUESTION

Not mentioned by Chairman Doherty was the report of a special Committee on Unionism for Engineers (the name of the committee has been changed to Committee on Employment Conditions for Engineers), appointed in March, 1943, with V. T. Boughton, of the *Engineering News-Record*, as its chairman. Mr. Boughton explained that he was making no formal report, as the committee had held no meetings. He called attention to the activities of the American Society of Civil Engineers in assisting its members in cases where professional engineers were being grouped, for purposes of collective bargaining, with union members of the subprofessional level. Attention was directed to the July and August issues of *Civil Engineering* for more detailed description of these activities.

There was reason to believe, he said, that the right of professional engineers to be recognized as a separate bargaining group in completely unionized industries would ultimately be recognized by the War Labor Board. To this end, he added, the American Society of Civil Engineers had enlarged its secretarial staff and was taking steps whereby the constitutions of its local sections could be amended to permit these sections to set up collective-bargaining groups.

REPORTS OF REPRESENTATIVES OF CONSTITUENT BODIES

After a luncheon, which was served at the Engineers' Club, the Council reassembled to listen to reports of the representatives of its constituent bodies. Space will not permit even a brief résumé of these reports which will be published later by E.C.P.D. They indicated that the war and preoccupation with its many obligations had not diminished interest of these bodies in the objective and program of E.C.P.D.

III THE ANNUAL DINNER

In accordance with its custom the Engineers' Council for Professional Development brought its 1943 Annual Meeting to a close with a dinner at the Engineers' Club to which officers and members of the boards of the constituent bodies had been invited. The dinner afforded an opportunity for informal discussion of E.C.P.D. plans and problems and for members of the boards of the constituent bodies to become acquainted with members of E.C.P.D.

S. D. KIRKPATRICK TOASTMASTER

The purposes of the dinner were excellently served by the manner in which Sidney D. Kirkpatrick, editor, *Chemical and Metallurgical Engineering*, presided in the capacity of toastmaster. In opening the two hours of discussion which followed the dinner, Mr. Kirkpatrick distinguished himself by naming every one of the 70 persons present and saying a few words about each. After the applause which greeted this accomplishment had subsided, Mr. Kirkpatrick called upon Everett S. Lee, newly elected chairman of E.C.P.D.

E. S. LEE EXPRESSES PRIDE IN E.C.P.D. ACCOMPLISHMENTS

Mr Lee said that he had formed an early connection with E.C.P.D. when he had served on it as a representative of the American Institute of Electrical Engineers. From his years of contact with the Council he had become proud of its accomplishments. He was confident that E.C.P.D. would perform any service demanded of it. It would work out by engineering methods the problems that would be presented to it.

He had debated about accepting the honor of becoming chairman of E.C.P.D. because of the pressure of his work. He realized, however, that everyone was busy and that he could call on every member of E.C.P.D. to help him.

There was much to be done by E.C.P.D. and all of it was interesting, Mr. Lee said. In his opinion, putting the Fairman plan into execution was the next task. The plan afforded opportunities for carrying out the objectives of E.C.P.D. in the engineering field itself. Ideas would be absorbed from this engineering atmosphere of local sections just as the leaves of a tree absorb life-giving qualities from the air. With the working out of the plan to bring E.C.P.D. closer to the engineers in the field, the work of the Council would continue and should go even beyond any goals that had been visualized.

BEAUBIEN INTRODUCED

In response to an introduction by Mr. Kirkpatrick, de Gaspé Beaubien, president-elect of The Engineering Institute of Canada, said that he considered it a great courtesy to be invited to the meeting of E.C.P.D. for the purpose of being educated concerning it. He considered particularly useful the wonderful lesson in chairmanship which Mr. Kirkpatrick had demonstrated by naming all of the seventy persons present. He would, he promised, tell something about the success Canada had had in engineering education when he returned next year.

E. S. BURDELL TALKS ON POSTWAR EDUCATION

Discussion of postwar problems of engineering education was opened by Edwin Sharp Burdell, director, Cooper Union for Advancement of Science and Art, New York, N. Y., who had been chosen for this task. Mr. Burdell recalled that one of his earliest appearances in New York had been at the 1939 annual dinner of E.C.P.D.[2] It was his present function, he said, to stimulate discussion, hence he would throw out some ideas without attempting to develop them.

TWO BASIC ASSUMPTIONS

He would start, he said, with certain basic assumptions.

First, we should find ourselves in the postwar world with prewar engineering schools, and not with perfected and ideal institutions. It would be out of the question to throw away what we had and start from scratch. Hence in the postwar world, we would start with a college, a faculty, a group of curricula, and a complexity of conditions. It would be necessary to make such an organization into what we would want it to be.

Next, Dr. Burdell said, he would base his discussion on the 1940 S.P.E.E. Report on Aims and Scope of Engineering Curricula.[3] This report, he asserted, had been studied by everyone interested in education and had laid the basis of a sound education. The report would also be the basis of his own discussion. It recognized two stems in engineering education; the scientific-technological and the humanistic-social. Both of these stems, he said, should receive support.

STILL A FOUR-YEAR COURSE

It was Dr. Burdell's personal opinion that engineering education after the war would still be limited to four years, within which time a good fundamental engineering training could be given. Some specialties would be taught as graduate subjects, but much work on the graduate level would have to be given in the industries. For example, advanced work in the field of aeronautics would have to be carried on in industry because certain necessary equipment, such as large wind tunnels, would not be found in most engineering colleges.

There would be a shifting of graduate responsibilities in the postwar period which would limit undergraduate studies to the fundamental sciences. Would industry "go along" with this new arrangement? In his opinion, it would. He had asked many industrialists this question. They had expressed alarm at the prospect of a postwar shortage of engineering graduates. One means of making up this shortage would be the granting of industrial leaves of absence to selected employers who would thus be given an opportunity to study in the universities for their master and doctor degrees.

DROP ACCELERATED CURRICULA AS SOON AS POSSIBLE

In so far as the accelerated programs which the engineering schools had been forced to adopt because of war conditions were concerned, it was Dr. Burdell's opinion that they be abandoned as soon as possible. (Applause.) It was not practicable, he said, to teach or to learn the year round; it was impossible with a twelve-month schedule for engineering teachers to acquire new teaching data and stimuli or for students to assimilate to good advantage what was taught them. On the other hand, engineering educational opportunities would be available the year round so that the student would be able to select the semester that would be most convenient for him to attend. Rest, recreation, and opportunities in the field would have to be made available to teachers, and this would demand more staff and extra staff. It would also be necessary to provide engineering students with opportunities for employment so that they would be able to meet the expenses of their education and acquire some practical experience. Under these new conditions the summer term would be as meaningful as any of the others.

INDUSTRY MUST HELP

In connection with the relation of the undergraduate program to industry, Dr. Burdell said that industry could be more helpful if it would specify the kind of a product it wished to employ. Industry had always been willing to tell what was wrong with engineering education but not how it expected to get the desired product. For example, there were plants which employed only one or a very few engineers. What did such plants want in the way of the education of these men? Many plants wanted engineers with administrative ability, but administrative ability could not be taught to undergraduates. If an industry were to employ engineering graduates, look them over, find out what could be done with them, and then send them back to the schools for intensive training, better results would be secured. As an example of this procedure Dr. Burdell cited the Sloan Foundation's arrangement with the Massachusetts Institute of Technology. Adoption of this procedure would, he thought, make it possible for the engineering schools to develop administrative ability. It was the function of engineering education to set up standards and traits, check these with industry, and work up some plan to the advantage of each.

UNDERGRADUATE CURRICULA

Dr. Burdell urged consideration of a plan evolved at Cooper Union for getting away from thinking of engineering curricula in terms of the conventional freshman, sophomore, junior, and senior years and rearranging them in a more natural sequence of "blocks"; first, training in the basic sciences; second, the principles of engineering; and third, advanced technology. (Through each block would run the two fundamental stems of scientific and humanistic studies.) Between each block the student would be subjected to "achievement" tests by means of which would be discovered what he had learned in problem solving, and not how much textbook knowledge he had retained in which one section of studies was unrelated to others. The method, he said, was already applied to students who came up for master and doctor degrees and it could be extended to the undergraduate level. Thus the student would be expected to be able to relate what he had learned in one course with the subject matter of the entire curriculum. This point of view, he said, was being taken at Cooper Union.

TEACHING

As to teaching in the postwar engineering school, Dr. Burdell said that the Army and Navy, faced with the necessity for rapid instruction, had used visual aids with marked success. Can such techniques be used in engineering instruction? he asked. He also suggested the setting up of teacher-training centers "to teach teachers to teach."

TECHNICAL INSTITUTES

The technical institute, said Dr. Burdell, had been, with a few exceptions, the "poor relation" of engineering education, and had labored in this inferior position. The technical institute, however, had an important function to perform. Engineering education looked to the technical institute to relieve it of material that was not at the college level. It should be possible for able men to transfer from the technical institute to the engineering college. One condition which held back the development of technical institutes was the competition faced by their graduates upon entering industry with engineering-college graduates who accepted positions at too low a professional level.

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[2] See MECHANICAL ENGINEERING, December, 1939, p. 911.

[3] Published under the title, "Whither Engineering Education?" MECHANICAL ENGINEERING, October, 1940, pp. 727–730.

CO-OPERATIVE COURSES

Dr. Burdell cited Stevens Institute of Technology and Northwestern University as examples of engineering colleges that were making good use of co-operative education. The scheme deserved open-minded investigation, he said. Not every school could successfully adopt this method of teaching because of its location with respect to industry. Too often co-operative education had been looked upon as an easy means of securing more students. Relationships between the schools and the industries into which students had been placed had been, too frequently, entirely fortuitous. Careful integration was called for. It was an obligation of the school to counsel the student so that he would get into a job that had something to do with the subjects he was studying. In other words, it was important that the industrial background be such as to warrant the benefits of an engineering education.

Co-operative education, in Dr. Burdell's opinion, would adapt itself to commercial schools and to liberal-arts colleges. Liberal-arts colleges should be thinking of their educational programs in terms of the employment of their graduates. Above all, co-operative education should develop well-rounded men and not turn out technical robots.

R. E. DOHERTY STRESSES EDUCATION FOR UNDERSTANDING

After Dr. Burdell had completed his extemporaneous address, Mr. Kirkpatrick called upon R. E. Doherty to open a discussion of some of the topics which had been mentioned.

Dr. Doherty said that he had entered engineering education from industry imbued with the missionary spirit. He wanted engineering students to have an opportunity to become well-educated men and to consummate that education in an understanding of the world in which they lived and their responsibilities in it.

There had always been a sense of apology in talking about the responsibility of citizenship in the past, but the war, its causes, and the situation in which the United States had found itself had made apology unnecessary. The nation had been unprepared to understand what the war was about, and it had become obvious that it was necessary to understand the philosophy underlying the issues which faced us. His plea to those who had responsibilities toward or influence with engineering students was that they support efforts at education for understanding.

The report of the S.P.E.E. Committee on Aims and Scope of Engineering Curricula, mentioned by Dr. Burdell, was, in his opinion, the first philosophy of engineering education which assumed that it was important for students to have an understanding of the world in which they lived. From that report he then read the following excerpts relating to the humanistic-social stem of engineering education.

> The humanistic-social studies should be directed toward:
>
> 1 Understanding of the evolution of the social organization within which we live of the influence of science and engineering on its development.
>
> 2 Ability to recognize and to make a critical analysis of a problem involving social and economic elements, to arrive at an intelligent opinion about it, and to read with discrimination and purpose toward these ends.
>
> 3 Ability to organize thoughts logically and to express them lucidly and convincingly both in oral and written English.
>
> 4 Acquaintance with some of the great masterpieces of literature and an understanding of their setting in and influence upon civilization.
>
> 5 Development of moral, ethical, and social concepts essential to a satisfying personal philosophy, to a career consistent with the public welfare, and to a sound professional attitude.
>
> 6 Attainment of an interest and pleasure in these pursuits and thus of an inspiration to continued study.

SWAIN URGES PRACTICAL WORK

P. W. Swain, editor of *Power*, stressed the need for practical work by engineering students during the summer. He said that some one had suggested the study of history for engineering students. In his opinion the study of history, to be of value, should enable a man to estimate in advance whether a course of action would be wise or foolish. If engineering students liked humanistic courses they would "go over;" the success would depend on the teacher.

DR. VAUGHN ON APTITUDE TESTS

At Mr. Kirkpatrick's request, President Cullimore introduced Dr. Kenneth Vaughn, of the Carnegie Foundation for the Advancement of Teaching, who was assisting the Committee on Student Selection and Guidance in its study of aptitude tests. He paid high tribute to E.C.P.D. because it knew what it wanted to do and had a program. Carnegie Institute for the Advancement of Teaching had considered the E.C.P.D. project brought to them by President Doherty as being worthy of support and had been contributing to it money and personnel.

PLANK SEES LACK OF MINING ENGINEERS

If the war were to last another year, said Prof. William B. Plank, head, department of mining engineering and metallurgy, Lafayette College, Easton, Pa., there would be practically no schools in mining engineering and chemical engineering because these subjects had not been included in the Army and Navy specialized training program. Instructors were being used in teaching other subjects or had been scattered in war work or the armed forces. On the other hand, there was a great demand for mining and metallurgical engineers. As to postwar considerations, it was his opinion that not many engineering students whose educational programs had been interrupted by the war would want to return to school. Many mining engineers would find opportunities in other countries. If the industries of the nation were counting on getting mining engineers at their own price after the war, or the schools a flood of young engineers to complete their mining-engineering education, they would, in his opinion, be doomed to disappointment. Even if an increased enrollment in the high schools should provide large numbers of potential students it would be found that by the time these men completed their education the same opportunities would not exist as would exist just after the war. This hiatus in the supply of mining and chemical engineering students should be of concern to the engineering societies; and the A.I.M.E., for one, had appointed a committee to study the situation.

Charles F. Scott said that it was one of the National Council of State Boards of Engineering Examiners' problems to examine prospective engineers desiring to enter the engineering profession. He thought Dr. Vaughn's methods could be applied.

CREESE AND ESHBACH ADVOCATE CO-OPERATIVE PLAN

James Creese, vice-president of Stevens Institute of Technology, and Ovid Eshbach, dean of engineering, Northwestern University, elaborated on the theme of co-operative education and pointed out how it might be made a powerful and useful factor in engineering education. Dean Eshbach said that the cooperative plan was not an alternative method of education. It was not a means whereby a student could earn his way through college. It was not a plan to finance an engineering school. It was not a plan for underprivileged boys. It was a plan for rapidly maturing engineering students. It was not correlation in a restrictive sense but a correlation of objectives in school with the problems a young man would meet in industry. It taught students, inadequately prepared to solve problems, how to arrive at their solutions. Industry wanted the co-operative plan, he said, and would be asking for it as a means of finding young men with a good fundamental education suited to the needs of their research organizations.—G. A. S.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The God of the Machine

The God of the Machine. By Isabel Paterson. G. P. Putnam's Sons, New York, N. Y., 1943. Cloth, $5^1/_2 \times 8^1/_4$ in., 292 pp., $2.75.

Reviewed by Philip L. Alger[1]

THIS book is truly a history of the world, a treatise on government, and a plea for human freedom, compressed into less than 300 pages.

Adam Smith first showed that the wealth of nations comes from free enterprise production, paving the way for the free trade that made the British Empire great. Henry Thomas Buckle in his "History of Civilization in England" first showed that the decadence of nations is directly caused by restrictions of individual freedoms, as Spain was ruined by the Inquisition and France by Louis XIV. Walter Lippmann in "The Good Society" showed the necessity of the free market as a condition of peace, and war as the inevitable outcome of the totalitarian system. Isabel Paterson now offers an explanation of why only free men, in a free economy, can create or maintain the "long circuit of energy flow" that civilization depends on.

In common with the three earlier works, it gives historic facts, and draws conclusions from the data, leaving the reader free to seek another explanation if he will. It is their use of the engineering method of inductive reasoning that gives these books their distinctive value. The following summary is largely composed of excerpts from Mrs. Paterson's book.

* * * * *

Mrs. Paterson's theme is the necessity for harmony between the character of government and the production order, or stage of economic development. The necessity for government arises with the extension of human relations over time and space. When a civilized man builds a house, the plans must be laid out and materials assembled over a considerable period, and paid for by savings involving exchange of labor with many other persons. He must, therefore, impose restraints on himself for objectives distant in time and needing to be directed through space. He lives in the past and future as well as the present. His initiative will be wasted unless he also inhibits himself; and, further, he must be able to count upon others who participate in the exchange to observe like long-term inhibitions. Throughout the series of exchanges in the transfer of goods or money from one owner to another, a succession of inhibitions must be maintained; otherwise at some point the goods will be consumed and no return made. For a civilized economy, there must be an agency to witness long-term contracts, and see that they are fulfilled in the absence of either of the parties, or to enforce an agreed penalty in case of default. The authority for this purpose is delegated to government.

Turning now to the productive processes by which civilization is sustained, it is clear that always and everywhere economic progress has come from the inventions, enterprise, labor, and savings of individuals. Original-minded, enterprising men provide the voltage that generates the production of goods and impels them through the channels of trade. As production increases in volume and diversity, a medium of exchange becomes necessary, and money becomes the means by which stored-up human energy is transferred from one place to another.

Thus the economic process may be regarded as an electric-power system, whose functioning depends on the maintenance of free channels for flow of goods to users and the return of their money equivalent to producers. If the energy circuit is interrupted, the flow ceases and decay starts. If energy is tapped off through a leakage circuit, production pines for lack of nourishment. If a short-circuit occurs, energy is released into destructive channels, as expressed by war or revolution.

These conceptions stem from the broad view of world history, which forms the background of Isabel Paterson's book. The contest between Rome and Carthage is seen as a trade war, with Rome at every disadvantage from lack of sea power and absence of industrial development. But Carthage insisted on commercial domination in regions she controlled, and staked her existence on a policy of exclusion. With Gibraltar in her grip, no vessel might pass into the Atlantic but her own, in peace or war, under any conditions. For losing a campaign, the Carthaginians crucified one of their admirals. When Scipio went into Africa, the Numidian auxiliaries went over to the Romans, and victory with them.

In their expansive period, the Romans had no single chief executive, and even in lesser positions they inclined to duality in office. Political offices were restricted to fixed and short tenure, with rotation in office and intervals in which an office-seeker was not eligible for re-election. They maintained civil control of the army for hundreds of years. Men of exceptional talent could rise from the ranks, and nothing was petrified into status.

The Romans possessed from very early times the conception of *jus*, which is wider than that of positive law laid down by authority, and denotes an order morally binding on the community. This idea of law, as an abstract concept, is not predicated by custom, leadership, or king; nor is it compatible with pure democracy. With all these, authority is arbitrary, being either given in the particular custom, or lodged in persons by precedence, or assigned to a majority. The Romans affirmed a moral order in the universe. The ordinary man wished to live under Roman law. The victorious legions were a result and not a cause.

But Caesar Augustus broke the patricians by proscription, put the army on a professional basis, paid off the plebs with a dole, and organized a bureaucracy which furnished places and perquisites for the upper and middle class. The latent opposition became negligible. The exactions of the bureaucracy increased, and the number of officials multiplied. More and more of the energy flow was diverted from production into the political mechanism. In the later Roman empire, the bureaucrats took such a large cut, at length scarcely anything went through the complete energy circuit. The producers received less, became impoverished, and consumed their own products instead of putting them into exchange. Taxes began to dry up, and the bureaucrats tried to sequestrate the energy at the source by a planned economy. Farmers were bound to the soil, workers to their benches, and no one could change his occupation or residence without permission. The currency was debased. Prices and wages were fixed, until at last there was nothing to sell and no work to be had. The Vandals came in, following the main trade routes, and there was nothing to stop them.

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[1] Staff assistant to vice-president, in charge of engineering, General Electric Company, Schenectady, N. Y. Mem. A.S.M.E.

As with Rome, the world accepted the British Empire because it opened world channels of energy for commerce. Though repressive (status) government was imposed on Ireland with very bad results, on the whole England lived by her invisible exports of law and free trade. Practically speaking, while England ruled the seas, any man of any nation could go anywhere in safety, taking his goods and money with him.

Summing up her analysis of the records, Mrs. Paterson says "History within nations consists of the struggle of the individual against government; and between nations, of the free economy against the closed economy. These are two aspects of the same process."

In free enterprise, the jobs are spontaneously created by the productive system. The person who wants work to be done hires directly the person who wants to work, each being free to seek the other, and each being interested personally in the benefit. Every want operates directly to stimulate a supply, every supply is a stimulus to discover a want. Throughout the longest series of exchanges, every person has a direct interest in getting the goods through, or producing them; so that there is an e.m.f. at each point in the long circuit of energy transmission.

On the other hand, the officials who manage the collective are not inventors, nor do they profit from production. With governmental ownership of all property, the workers have no resources of their own to fall back on, and must fit into whatever groove the government provides. Thus, under the collectivist system, all energy flow is forced into a single channel, with no locally created voltages of self-interest to carry the flow along.

For the exercise of intelligence on invention and discovery, a man must have surplus materials, time, and energy at his personal disposal, with freedom to choose whatever occupation he prefers. For the exercise of volition, and for interest to motivate the flow of energy in channels that will be maintained, every exchange of goods and labor must be made by free contract. If Thomas Edison or Henry Ford had been put to work digging ditches under duress, one could easily calculate their total energy output. Left to their own devices, as they were, it is impossible to say how much energy they actually released into production. The money which accrued to them in profits gave them greater scope to experiment, and went back into production multiplied exponentially.

The organization of actions over time and space constitutes the science of engineering. The engineering problem then is to organize the long circuit of energy flow for *free men*. The whole problem is solved by observing throughout the principle of contract. Contract is the principle of the true dynamic economy.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Harrison W. Craver, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

* * * * *

With the general analysis and the emphasis on the necessity of freedom of contract as a condition of either peace or human progress, the reviewer is in entire accord. However, in the latter part of the book, especially, Mrs. Paterson is extremely critical of many well-meaning persons and established institutions, on the basis of their restrictive or collectivist tendencies. She emphasizes over and over again the dead hand of government, with its powers of restriction and expropriation. With many of these critical and wellnigh despairing comments on the acts of government as we have known them, the reviewer disagrees.

Mrs. Paterson cannot speak too highly of the United States Constitution, with its system of checks and balances. Nothing is more essential to the welfare of a nation, Mrs. Paterson says, than the countercheck on government by legitimate means. To quote her concluding paragraph:

> "Whoever is fortunate enough to be an American citizen came into the greatest inheritance man has ever enjoyed. He has had the benefit of every heroic and intellectual effort men have made for many thousands of years, realized at last. If Americans should now turn back, submit again to slavery, it would be a betrayal so base the human race might better perish. The opportunity is equally great to justify the faith which animated that long travail, and bequeathed them such a noble and happy heritage."

Books Received in Library

TREATMENT OF EXPERIMENTAL DATA. By A. G. Worthing and J. Geffner. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, London, England, 1943. Cloth, 6 × $9^{1}/_{2}$ in., 342 pp., illus., diagrams, charts, tables, $4.50. As an aid to scientists and engineers in presenting experimental data clearly and usefully, this book presents and discusses the following topics: rules for graphing, methods of smoothing and tabulating, a moderately extended treatment of precision indexes, the essentials of correlation, Fourier series and harmonic analysis as a means of representing data, and the use of determinants as a means of simplifying computations.

TENNESSEE VALLEY AUTHORITY. By J. S. Ransmeier. Vanderbilt University Press. Nashville, Tenn., 1942. Cloth, 9 × $5^{1}/_{2}$ in., 486 pp., diagrams, charts, tables, $3. The aim of this study is to contribute to clarification of the problem of cost allocation when river control is undertaken for multiple purposes. The author studies the problem as presented by the Tennessee Valley Authority. The development of the program is presented, the various theories and problems of cost allocation are discussed critically, and the planning and policy examined.

TIME STUDY FOR COST CONTROL. By P. Carroll, Jr., foreword by C. D. Dyer, Jr. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1943. Cloth, $9^{1}/_{2}$ × 6 in., 301 pp., illus., diagrams, charts, tables, $3. This book is intended for industrial engineers and executives interested in installing or improving a system of time study. It explains the application and advantages of time study based on predetermined standards, describes the establishment of a standards department, and outlines step by step a practical method of completing the time-study measurement and control of cost without rearranging the shop.

(The) THEORY AND PRACTICE OF HEAT ENGINES. By R. H. Grundy. Longmans, Green & Co., London, England, New York, N. Y., and Toronto, Canada, 1942. Cloth, $5^{1}/_{2}$ × 9 in., 723 pp., illus., diagrams, charts, tables, $6.25. This textbook offers a course covering steam generators, reciprocating steam engines, steam turbines and internal-combustion engines in one volume. It is intended to cover the practical side of the subject and the accompanying theory to a stage from which an easy step may be made to more specialized books. The book is profusely illustrated with drawings, considerable attention is given to historical development, and the text is clear and readable. A good picture of modern practice, especially British, is provided.

▶ **PLANNING AND POST-WAR PLANNING—STATE ORGANIZATIONS**, Membership Directory, September, 1943. American Society of Planning Officials, Chicago 37, Ill. Paper $8^{1}/_{2}$ × 11 in., 34 pp., manifold copy, $1. A directory of these organizations, giving the names of officials and members, and office addresses.

A.S.M.E. BOILER CODE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with Committee Secretary, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of Boiler Code Committee to all of its members. The interpretation, in the form of a reply, is prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval and then issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations formulated at the meeting of September 10, 1943.

CASE NO. 1000

(Interpretation of Par. M-11)

Inquiry: Under present emergency conditions, it is very difficult, if not impossible, to secure washout plugs with nonferrous threads for use in miniature boilers. In view of these conditions, may washout plugs with steel threads be substituted?

Reply: It is the opinion of the Committee that washout plugs with steel threads may be used in miniature boilers until this Case is annulled or until such time as plugs with nonferrous threads are again readily obtainable for this service.

CASE NO. 1001

(Interpretation of Par. P-112c)

Inquiry: May the provisions of Par. P-112(c) requiring a backing ring for all pipe or tube single-welded circumferential butt joints be suspended provided it can be demonstrated that complete penetration at the root of the joint can be obtained without a backing ring?

Reply: It is the opinion of the Committee that single-welded circumferential butt joints of pipe or tubes may be made without a backing ring provided:

(1) The procedure and operator are qualified as required in Section IX of the Code without the use of a backing ring;

(2) Complete penetration at the root of the weld is obtained and the depth of weld is not less than the minimum wall thickness at the abutting edges not including the required reinforcement.

CASE NO. 1002

(Special Ruling)

Inquiry: Par. U-13(e) of the Code authorizes, with certain limitations, the use of pipe in accordance with Specifications S-18 and S-58 for the pressure parts of unfired pressure vessels. May spiral welded pipe made in accordance with A.S.T.M. Specifications A 139-42 be used instead of the above-named material?

Reply: It is the opinion of the Committee that material complying with A.S.T.M. Specifications A 139-42 may be used for pressure parts of unfired pressure vessels under Par. U-13(e) on the same basis as Specifications S-18 and S-58. The working stresses shall be the same as those provided for Specification S-58 Grade A, in Table U-2$^{1}/_{2}$.

CASE NO. 968 (Reopened)

The text of this Case appeared in the June, 1943, issue of MECHANICAL ENGINEERING for comment, and was approved by the Boiler Code Committee in that form. The complete Case appears on interpretation pages 91 to 94.

CASE NO. 979 *(Reopened)*

(Special Ruling)

Inquiry: Due to the improvements in design, construction, and materials, may the design stresses for Pars. U-68 and U-69 vessels and the joint efficiency in fusion-welded construction be increased from present Code requirements?

Reply: It is the opinion of the Committee that existing Code rules shall be complied with except as herein modified.

The maximum allowable working pressure for welded or seamless unfired pressure vessels, and for tubes for use in such vessels, may be determined as follows:

(*A*) With the exceptions stated below, the shells and heads of Par. U-68 vessels may be allowed a joint efficiency of 95 per cent, and the shells and heads of Par. U-69 vessels a joint efficiency of 85 per cent, and may be designed by using the formulas in Pars. U-20(a) and (b), U-36, U-39, and U-59 with maximum design stresses given in Table U-2 multiplied by 1.25, and to the calculated thickness for steam, water, and air vessels shall be added a corrosion allowance of one sixth of the calculated thickness, or $^{1}/_{16}$ in., whichever is the smaller. Vessels in other corrosive services shall be provided with appropriate corrosion allowances. The following restrictions shall apply to all such vessels:

(1) The weld reinforcements shall be removed flush with the surface of the plate for all Par. U-68 vessels. In all cases, for both Pars. U-68 and U-69 vessels, where edges of unequal thicknesses are abutted, the edge of the thicker plate shall be reduced by a taper of not less than 4 to 1. Other joint details shall conform with the requirements of Par. U-72.

(2) Stresses due to hydrostatic head shall be taken into account in determining the thickness to be used, also the total of other stresses due to loads such as the weight of the vessel, water, and distances between vessel supports, if these stresses increase the average stress over substantial sections of the shell or head by more than 10 per cent;

(3) Large temperature differentials in heads or shells shall be avoided or the effect reduced by shields or other suitable means;

(4) For heads the increased design stresses as defined in this Case may be used only for flat heads and for hemispherical or ellipsoidal heads with pressure on the concave side;

(5) The following parts shall be designed in accordance with the present rules of the Code and may be used with shells which are constructed in accordance with the rules of this Case:

(*a*) Dished heads, other than hemispherical or ellipsoidal;

(*b*) All unstayed dished heads with pressure on the convex side;

(*c*) Ellipsoidal heads with flanged-in manholes;

(*d*) All stays, braces, and parts requiring staying;

(*e*) Flanges.

(6) In determining the maximum size of an unreinforced opening under Par. U-59(a), the value of K to be used in connection with the chart in Fig. U-5 shall be 1.1 times the value of K computed by the formula of that paragraph for the part of the shell that contains the opening. When computing K by the formula in Par. U-59(a), the pressure P shall be that for which the vessel is designed, S shall be 1.25 times the value from Table U-2, and t shall be the actual full thickness of the shell at the location of the opening. Where K so computed is unity or greater, the maximum size of unreinforced opening shall be 2 in.

(7) Par. U-68 vessels, and those Par. U-69 vessels that are required to be stress-relieved, constructed under these alternate rules, shall be stress-relieved in accordance with Par. U-76, with the additional provision that these vessels shall be allowed to cool slowly in a still atmosphere to a temperature not exceeding 600 F.

(*B*) In the determination of thicknesses for internal pressure of ferrous tubes and pipes, the design stresses in Tables U-2 and U-2$^{1}/_{2}$ may be multiplied by 1.25 for use in the formula in Par. U-20(c).

(*C*) For the chrome-nickel materials covered by Case No. 897, the increased stresses and joint efficiencies are permitted up to a temperature not to exceed 900 F, but within the other temperature limitations of that Case.

(*D*) Pars. U-68 and U-69 vessels constructed in accordance with the requirements of this Case and other applicable Code rules are considered safe and shall be stamped in accordance with Par. U-66, the Code symbol to be followed by the letter "A," which also shall be shown on the manufacturer's data report.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Seventh Annual Joint Fuels Conference of A.I.M.E. and A.S.M.E.—Record Meeting at Pittsburgh, Oct. 28-29[1]

THE seventh in an unbroken line of Annual Joint Fuel Conferences was held at the William Penn Hotel, Pittsburgh, Pa., October 28 and 29, under the auspices of the Fuels Division of A.S.M.E. and the Coal Division of A.I.M.E. This was also the scene of the first of these conferences, held in 1937, and considerable interest attached to a comparison of the two meetings. The first conference was attended by about 250 members of the two societies, while this most recent one had a total attendance of 500. It was the concensus, expressed by the local chairman, T. E. Purcell, vice-president, A.S.M.E., that the initiators of this project, J. B. Morrow, president, Pittsburgh Coal Company, and Tom Marsh, Iron Fireman Corporation, might well be proud of the growth of their idea.

The papers presented at the meeting are generally concerned either with utilization problems or with fuel production. Depending on the main emphasis they will be published either by the A.I.M.E. or the A.S.M.E. who co-operated in sponsoring the meeting. Four technical sessions, which occupied the mornings and afternoons of the two-day meeting, were marked by lively discussion and covered topics ranging from mine management to a war program, the use of coal-in-oil fuels, as investigated by the U. S. Bureau of Mines, and trends in a panel discussion on fuels, led by Julian E. Tobey.

Coes and Gates Present

The first session opened with an address of welcome by Harry M. Moses, president of the Frick Coal and Coke Company, which was acknowledged by Harold V. Coes, President, A.S.M.E. It may be noted, incidently, that this marked the first time the Fuels Conference was attended by a president of the A.S.M.E. To make the occasion complete, the President-Elect of the Society, R. M. Gates, also attended.

Hebley Tells of Australian Experiences

Luncheon on Thursday was enlivened by an entertaining and instructive discussion of his experiences "Down Under" by H. F. Hebley, director of research of the Pittsburgh Coal Company and chairman of the A.S.M.E. Fuels Division. Mr. Hebley recently returned from a mission to Australia under the jurisdiction of the Board of Economic Warfare and the Petroleum Administrator for War. The visit was in the interest of oil production for the war effort, and Mr. Hebley noted that "practically every fourth car one sees in Sidney has a gas producer on the back."

The early evening saw a novelty at these meetings—a social hour sponsored by the local committee at the suggestion of J. B. Morrow. The occasion were enjoyed by all persons present, many of whom agreed that the few minutes of let-down were valuable preparation for closer attention to the subsequent events.

Kreisinger Receives Percy Nicholls Award

The annual dinner was presided over by T. E. Purcell, chairman of the local committee, and was the occasion of two main features. One was the presentation of the Percy Nicholls Award to Henry Kreisinger, manager of development and research of the Combustion Engineering Company, Inc., of New York. This award, presented for the second time this year, was established by the Joint Fuels Conference in recognition of notable "scientific or industrial achievement in the field of solid fuels," and was named for the late Percy Nicholls, who was supervising fuel engineer at the Pittsburgh Experiment Station of the U. S. Bureau of Mines until his death. The citation of the award to Mr. Kreisinger read:

> His contributions to the organized study of the coals of the United States and his research work in the utilization of solid fuels have helped greatly in the development of the science of fuel technology.
>
> His years of study of the processes of combustion have developed for all mankind a greater knowledge of the phenomena involved and have led to a more thorough understanding of the basic and practical aspects of the economical burning of solid fuels.
>
> His personal contributions to the development of the safe and economical use of pulverized coal have added greatly to the usefulness of solid fuels not otherwise economically useful and have thereby in effect vastly increased the amount of fuel energy available for the use of mankind.

W. G. Christy, member of the Council of The American Society of Mechanical Engineers, presented the award.

Kreisinger Talks on Coal-Test Procedures

In accepting the Percy Nicholls Award, Mr. Kreisinger said:

> I wish to express my appreciation of the honor conferred upon me by the Percy Nicholls Award. I have reached an age when a man begins to look back on his life and wonders whether he has made the best of his opportunities. During such moments it will give me much satisfaction to know that there are men who think that I have done something worth while in my life. In my short talk to you I want to take you back some forty years and tell you how organized study of coals was started. A comparison of the early coal test procedures with our present methods should indicate the progress that has been made.

Mr. Kreisinger then went on to say that organized study of coals started at the Coal Testing Plant built for that purpose at the St. Louis Exposition in 1904, set up by the United States Geological Survey in order to determine the fuel value of coals from deposits it had studied. He told how the Bureau of Mines had been created in 1910 as a result of this coal-testing experience in which about 400 steaming tests had been made on widely different coals from almost every part of the United States. These tests, he said, revealed that the efficiency obtained with the various coals was practically constant and that the amount of steam that could be made was directly proportional to the heat value of the coal. The efficiency was shown to depend on the design of the boiler in which the fuel was burned.

Conclusions drawn, he said, led to important changes in methods of testing fuels. Determination, by the calorimeter, of the heating value of the fuel supplanted the running of boiler tests. Heat transfer, as applied to steam boilers, was also studied. Thus the Coal Testing Plant became an important factor in collecting and disseminating useful knowledge pertaining to the functioning of the steam boiler. The importance of the presence of ash was also discovered, he said, so that, within recent years, the study of the use of coal had been directed toward the composition of the ash, its fusion temperature, and its behavior in the furnace.

A.S.M.E. Calendar

of Coming Meetings

November 29–December 3, 1943
A.S.M.E. Annual Meeting
New York, N. Y.

April 3–5, 1944
A.S.M.E. Spring Meeting
Birmingham, Ala.

May 8–10, 1944
A.S.M.E. Oil and Gas Power Division Meeting
Tulsa, Okla,

June 19–22, 1944
A.S.M.E. Semi-Annual Meeting
Pittsburgh, Pa.

(For coming meetings af other organizations see page 30 of the advertising section of this issue)

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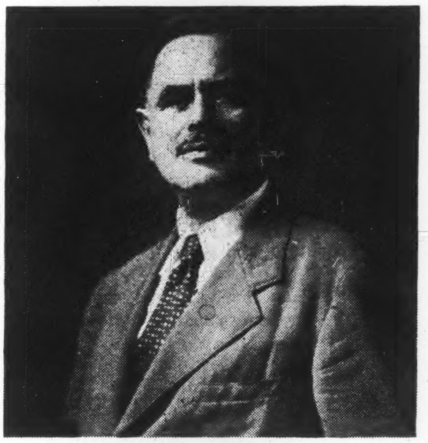
[1] Report prepared by Martin A. Mayers, Elliott Company, Jeannette, Pa. Mem. A.S.M.E.

High Lights of Henry Kreisinger's Career

Mr. Kreisinger was born in Radnice, Czechoslovakia, in 1876 and was naturalized in Chicago in 1898. He received the degree of Bachelor of Science in 1904 and the degree of Mechanical Engineer in 1906 from the University of Illinois. Previous to joining the Combustion Engineering Company, he was engineer with the U. S. Geological Survey in St. Louis and Pittsburgh; fuel engineer with the Clinchfield Fuel Company, Spartanburg, S. C.; and fuel engineer with the U. S. Bureau of Mines in Pittsburgh, in charge of fuel investigation.

The Chanute Medal was awarded to Mr. Kreisinger in 1907 by the Western Society of Engineers for a paper prepared in collaboration with W. T. Ray, which is believed to have presented for the first time an analysis of the influence of gas flow on heat transmission.



HENRY KREISINGER WHO RECEIVED PERCY NICHOLLS AWARD AT A.I.M.E.-A.S.M.E. FUELS CONFERENCE

Mr. Kreisinger is the author of some 70 articles and papers, many of which have appeared in MECHANICAL ENGINEERING and other technical magazines. He has patents or patents pending on a great number of fuel inventions, such as boiler and furnace installations, driers, economizers, a dust collector, a fuel-handling system, and a fuel-pulverizing system. He has done important constructive work on committees of the A.S.M.E., A.I.M.E., American Gas Association, and other groups.

Colonel Walsh Talks on Logistics

The other principal event of the evening was an address by Col. James L. Walsh on "Logistics—the Key to Quick Victory." Colonel Walsh, who is chairman of the War Production Committee of the A.S.M.E., said that "the very future of civilization is bound up in the rapid and complete solution of a single, highly complicated but completely integrated problem in logistics which extends over 56,000 miles of life lines from the United States to all five continents and every part of the seven seas. The best hope on earth of nearly 90 per cent of the world's population is not merely a victory for the United Nations, but a quick victory, to save human lives, perhaps our own lives." Emphasizing that man's fighting ability depends on getting weapons, supplies, and equipment enough where and when needed, Colonel Walsh said that "man, barehanded, cannot 'lick his own weight' in bumblebees, or even in mosquitoes, much less in microbes. That, in a nutshell, is the fundamental reason for there being such a thing as the science of logistics—the 'know-how' of providing the means to defeat and outlive the innumerable enemies that sought the destruction of man."

National Fuel Efficiency Council Described

At the luncheon meeting on Friday, Tom Cheasley described the National Fuel Efficiency Council recently appointed by Dr. R. R. Sayers, director of the United States Bureau of Mines. This Council, composed of a number of prominent fuel engineers, proposes to set up regional control units for the conservation of fuel as a wartime measure. They hope to bring the conservation program into each plant and home throughout the nation where fuel is used.

Local Committee

The local committee consisted of a General Committee of which T. E. Purcell was the chairman, and H. F. Hebley, L. E. F. Wahrenburg, A. W. Thorson, T. J. Barry, and H. P. Greenwald, members, with the following subcommittees:

General Arrangements, T. J. Barry; Hotel and Reservations, G. A. Shoemaker; Inspection Trips, M. R. McConnell; Publicity, J. T. Ryan, Jr.; and Program and Papers, M. A. Mayers.

A.S.M.E. War Production Committee Visits Aberdeen Proving Ground

MEMBERS of the A.S.M.E. War Production Committee visited the Aberdeen Proving Ground, Md., on October 6 at the invitation of Major General L. H. Campbell, Jr., Chief of Ordnance, U. S. Army.

The committee witnessed firings and test maneuvers of latest types of weapons, including tanks, self-propelled artillery, amphibious trucks, "block busters," and incendiary bombs. At the conclusion of the visit Col. James L. Walsh, chairman of the War Production Committee, said: "The fighting equipment being furnished by the Ordnance Department, United States Army, to our combat forces and those of the United Nations continues to lead the world from an engineering standpoint." The committee was also given an opportunity to inspect captured enemy equipment.

Members of the committee visiting Aberdeen, in addition to Colonel Walsh, included: C. E. Meissner, vice-president, Edw. G. Budd Mfg. Co., Philadelphia, Pa.; Rear-Admiral J. A. Furer, Navy Department, Washington, D. C.; A. R. Stevenson, Jr., General Electric Company, Schenectady, N. Y.; T. H. Wickenden, International Nickel Co., New York, N. Y.; R. M. Gates, president-elect, A.S.M.E.; H. V. Coes, president, A.S.M.E.; Daniel S. Ellis, Lima Locomotive Works, Lima, Ohio; Ernest Hartford, executive assistant secretary, A.S.M.E.; and H. B. Lewis, executive secretary, Manufacturing Engineering Committee, A.S.M.E.

Hanson W. Baldwin Describes Aberdeen

Writing in the *New York Times*, Oct. 16, 1943, Hanson W. Baldwin gave the following description of the Aberdeen Proving Ground, which is quoted with permission.

Aberdeen has long been the nerve center of the Army's ordnance program; here have been developed and tested and refined tanks, guns, shells, fuses, trucks and all of the thousand-and-one types of weapons and vehicles that the modern army needs in battle. But since the war Aberdeen has become—under Maj. Gen. Charles T. Harris, Jr., its commanding officer—not only a testing ground for our own arms, but also for the enemy's. Captured enemy material and some of the weapons of Allied powers are brought here, to be examined and tested.

Aberdeen is not only a great proving ground; it is also a museum—one of the most complete in the world—of the weapons of yesterday and the weapons of today. There are many types of captured enemy matériel—German, Italian, and Japanese, some of it novel in design and concept. Generally speaking, German matériel is newest and best of the equipment of the Axis powers; Italian is generally very varied with few standard types, Japanese is old but serviceable. Our own modern equipment does not suffer in comparison with the enemy's; our workmanship is often finer and our designs are better suited to mass production.

Many of the latest American weapons which Aberdeen is now testing or developing are naturally still in the secret category; the enemy will learn their nature later to his sorrow. Most of them cannot be described.

But they include devices and arms of every type from antiaircraft guns that shoot higher than any plane will fly to new tanks of increased armament, improved maneuverability and reliability, and greater speed.

Modern American Army trucks, as a result of our lessons in North Africa, will have "soft-top" cabs, with a scarf ring for a machine gunner above the assistant driver's seat. Our field artillery has new prime movers—$7^1/_2$-ton trucks and speedy tractors—which give great field pieces, which only four years ago moved with the speed of a team of oxen, the mobility of a Ford car.

Aberdeen has tested and okayed the great 57-ton heavy tank, built by the Baldwin Locomotive Works, a huge monster with a three-inch antitank gun and 37 mm piece, which is ready to match shots with the German "Tiger" whenever the using services want a larger tank than the 30-ton mediums that are now doing such yeoman service on the field of battle.

Abderdeen is also proving—the sound of the guns echoes far into the night—hundreds of the famous and highly successful guns of the field artillery. Scores of the 155 mm guns or "Long Toms," as the soldiers call them, and of the eight-inch howitzers, which are built for the same carriage, were lined in long rows here awaiting shipment, and beside them, were the other tried-and-tested "twins" of the field artillery—the eight-inch gun, and the 240 mm howitzers, also mounted on identical carriages.

In small arms, the latest weapons under test include the now tried Carbine, Caliber .30 M-1, with its effective range of 300 yards, and its light weight of five pounds.

SOME MEMBERS OF THE A.S.M.E. WAR PRODUCTION COMMITTEE INSPECT SMALL ARMS AT ABERDEEN PROVING GROUND, OCTOBER 6, 1943
(Left to Right: A. R. Stevenson, Jr., C. E. Meissner, Rear Admiral J. A. Furer, R. M. Gates, D. S. Ellis, Col. James L. Walsh, T. H. Wickenden, H. B. Lewis, and Ernest Hartford.)

A new M-3 submachine gun, sometimes called a "machine pistol," designed to replace and supplement the heavier "Tommy" gun, is also being proofed.

The gun, which fires a thirty round clip of .45 caliber slugs at an effective range of about 100 yards, has a folding shoulder stock, and can be fired from hip or shoulder. It weighs only seven and a half pounds and in quantity production can be manufactured for only $18. It has a rate of fire of 450 pounds per minute.

How to Help Co-Ordinate E.C.P.D. and Society Sections

"WILL you Help?" is the title of the final report of J. F. Fairman to the Engineers' Council for Professional Development on how to expedite the common interests of local sections and student branches or chapters and the E.C.P.D.

The report includes the text of a proposed pamphlet which emphasizes professional training and professional recognition.

The original problem which Mr. Fairman solved was how to shorten lines of communication between committees of E.C.P.D. and local sections. His answer was expressed in a chart which provided for direct lines from E.C.P.D. local sections of each of the eight societies constituting E.C.P.D.

"Will You Help?" first presents an excellent digest of the objectives of E.C.P.D., its program of vocational orientation, its criteria of engineering education and its accrediting procedure, the professional development of the young engineer, and professional recognition.

E.C.P.D. functions by recommendations to the governing boards of the eight participating bodies. When such recommendations are approved by each board, E.C.P.D. acts or the regular procedure of each Society is utilized to obtain action by the local sections or student organizations.

The societies constituting E.C.P.D. are: The American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, Inc., American Institute of Electrical Engineers, American Institute of Chemical Engineers, National Council of State Boards of Engineering Examiners, Society for the Promotion of Engineering Education, and The Engineering Institute of Canada. Each society appoints three representatives for a term of three years each. These 24 constitute E.C.P.D. and operate largely through five committees as follows: Student Selection and Guidance, Engineering Schools, Professional Training, Professional Recognition, Canons of Ethics, and a new committee on Unionism.

The Plan

In almost every urban and industrial center and on every engineering college campus there are terminal points of these channels in the form of local branches, chapters, or sections, including student branches, of the national engineering societies, and of S.P.E.E.

"The plan" is that in such urban or collegiate centers, joint groups be organized to work in the local field on the immediate objectives of E.C.P.D. under the general inspiration and guidance of E.C.P.D.'s four standing committees.

If the plan were carried out, the existing channels from each of the national headquarters of the participating bodies to the ocal units of those societies would be utilized more effectively for the flow both ways, between Council or its committees and the local joint group, of information and inspiration. It is a part of the plan that the local groups enter into direct correspondence with the standing committees of E.C.P.D. in order mutually to take advantage of the inspiration, enthusiasm, and experience of individuals working locally and nationally in corresponding fields. Thus, each local group would feel assured that it had both the approval of and an urge by the national body for active participation in the joint programs represented by E.C.P.D. Thus, the approved policies and programs of Council and its committees could find effective national expression *at the level of the individual engineer.*

"Where to Begin" is a short chapter on the literature available to help local chapters in organizing high-school counseling.

The program sponsored by the Committee on Professional Recognition is designed to interest and indoctrinate student chapters and branches.

"How to Begin" says:

"Arrange an informal meeting with the leaders of other engineering organizations in your locality for the purpose of exploring what most urgently needs to be done in your territory to promote the immediate objective of E.C.P.D.

"Report your findings, your plans as they develop, your difficulties as you encounter them, and your progress, periodically, through the normal channels of communication and organization in your particular society. Ask for information and assistance in the same way."

Inquiries may be addressed to Engineers' Council for Professional Development, 29 West 39th Street, New York 18, N. Y.

A.S.M.E. to Organize Consulting Engineering Professional Group

UPON the recommendation of the Standing Committee on Professional Divisions, the Executive Committee of the Council of The American Society of Mechanical Engineers, on Oct. 2, 1943, authorized the establishment of the Consulting Engineering Professional Group to be organized in its new form by the present Special Committee on Consulting Practice.

The petition to establish such a group was the result of an open forum on consulting-engineering problems held December, 1942, under the auspices of the A.S.M.E. Special Committee on Consulting Practice. The Committee recommended that the present committee, consisting of three members, be expanded to five members, with a rotating membership, the five members to be designated as the executive committee of the group; that the group function under the auspices of the Management Division and be composed of members of the Society, engaged in the active practice of consulting engineering, or members who have an active interest in consulting work. It was proposed to schedule at least one meeting each year on the subject of consulting-engineering work, covering the problems of the consultant, an educational program on the use and value of consulting engineers, and the means of having such a program made effective.

S. Logan Kerr is chairman, and Paul L. Battey and M. X. Wilberding are the other members of the present Committee on Consulting Practice.

President's Page

THIS is my final message.

In closing this series I wish to say that, from my experience as president the past year, the general policies of the Society seem to be sound. Some modifications, of course, have to be made from time to time to meet ever-changing conditions. Too often policies are taken for granted. Every so often all the important ones should be critically revised with two questions in mind:

1 Does the policy conform to the present intent of the membership?

2 Is the policy suitably implemented so as to be effective and is it competently administered?

For example, I think our policy of having the Society assist in the war effort to the greatest extent practical has been made quite effective. I have commented on this in a previous president's page.

Our policies with respect to student branches and student members have had to be modified to meet the conditions imposed by the war's effect on education.

Similarly, our financial and investment policy has been attuned to the times.

Our editorial policies have been modified and adjusted to meet current conditions.

Your Council and the Executive Committee of the Council endeavor to keep the Society's policies in tune with the times and to see that the policies are really effective.

I think that the Society should keep on its present course. I would like to see it, however, give careful consideration as to how its facilities may be put to practical and effective use, after the war, on rehabilitation and reconversion problems. Perhaps the technique that has been developed so successfully for the War Production Clinics can be adopted and suitably modified to deal effectively with the problems of reconversion.

(*Signed*) HAROLD V. COES, *President*, *A.S.M.E.*

Actions of A.S.M.E. Executive Committee

At Meeting in Society Headquarters on October 29

THE Executive Committee of the Council of The American Society of Mechanical Engineers met at A.S.M.E. headquarters on Oct. 29, 1943, with Harold V. Coes presiding. In addition to Mr. Coes there were present Clarke Freeman, vice-chairman, George E. Hulse, Clair B. Peck, and A. R. Stevenson, Jr., of the committee; Robert M. Gates, president-elect; G. L. Knight (Finance), W. A. Carter (Professional Divisions); C. E. Davies, secretary, Ernest Hartford, executive assistant secretary, and R. L. Sackett, assistant to the secretary.

During its afternoon session, the committee met with members of the Standing Committee on Admissions and the Special Committee on Membership Development. The Admissions Committee members present were: S. H. Libby, chairman, S. D. Sprong, T. M. Knoop, and D. W. R. Morgan; and of the Committee on Membership Development, W. S. Finley, Jr., chairman, W. M. Sheehan, and N. O. Wynkoop. C. B. Peck presided at this session in the absence of Mr. Coes.

Personnel Service

It was reported that the Engineering Societies Personnel Service, Inc., was enjoying "a comfortable financial position" so that a contribution by the Society for the current year would not be necessary.

E. I. C. Agreement

Approval by letter ballot of the agreement between The Engineering Institute of Canada and the A.S.M.E. was reported. A.S.M.E. local sections and student branches in Canada are to be notified of the agreement and their co-operation is requested.

Model Law

Letter-ballot approval and endorsement of the Model Law for Registration of Professional Engineers and Land Surveyors, as revised at a conference held May 24, 1943, was reported.

Postwar Planning

Mr. Coes announced the personnel of the Committee on Society Program on Postwar Planning, as follows: E. G. Bailey, chairman, William L. Batt, R. E. Doherty, Ralph E. Flanders, and David C. Prince.

Appointments

The following appointments were reported:

Special Committee on Membership Development, P. T. Sowden, vice-chairman.

General Advisory Committee, Management Division, H. B. Maynard, R. A. McCarty, Wm. R. Mulee, and J. M. Talbot.

Sectional Committees on Standardization: Shaft Couplings, Integrally Forged Flange Type for Hydroelectric Units, B49, D. J. McCormack and R. E. B. Sharp; and Minimum Requirements for Plumbing and Standardization of Plumbing Equipment, A40, A. M. Houser.

National Management Council, J. M. Talbot, representative, Wallace Clark, alternate.

National Council of State Boards of Engineering Examiners, annual meeting, Indianapolis, Ind., Oct. 25–26, 1943, V. M. Palmer.

Unveiling of plaque on hydraulic laboratory at Lehigh University, Oct. 18, 1943, Lewis F. Moody.

Alex D. Bailey Chairman of Washington Award Commission

ALEX D. BAILEY, fellow A.S.M.E., has been elected chairman of the Washington Award Commission for 1943-1944. Mr. Bailey has served on the Commission as one of the representatives of the Western Society of Engineers since 1941.

A.S.M.E. representatives on the Commission are C. C. Austin and W. S. Monroe.

Consultative Committee on Engineering Formed to Advise W.M.C.

THROUGH the initiative of R. L. Doherty, chairman of Engineers' Council for Professional Development, an effort was made to organize a committee which might be advisory to the War Manpower Commission on problems of engineering personnel.

A meeting was called of representatives of industry and engineering education to consider ways and means. President Elliott, of Purdue University, then chief, Professional and Technical Division of the War Manpower Commission, was helpful in organizing a committee to advise with him. The need for engineers in industry was critical and plans for preparing engineering students to take their proper places in the armed forces or in industry were indefinite. Changes in the organization of the W.M.C. took place and President Elliott resigned in order to return to Purdue University. This involved a new study of the functions of such a committee. Representatives of engineering societies were appointed and a bill of particulars naming the Consultative Committee to act as mouthpiece for the societies was approved by all the societies except the American Society of Civil Engineers.

The Consultative Committee has now been accepted by the War Manpower Commission to advise on problems of engineering personnel in the armed forces or in industry. It has been helpful in discussions of engineering education, in considering the deferment of necessary personnel in industry, and in obtaining classification as eligible for deferment those enrolled students, whose records in engineering courses are good, who are scheduled to graduate by July 1, 1945.

U.E.T. Elects Officers

F. MALCOLM FARMER, member A.S.M.E., vice-president and chief engineer of the Electrical Testing Laboratories, New York, N. Y., and an authority on electrical measurements, electrical insulating materials, and high-voltage cables, has been elected president of United Engineering Trustees, Inc., the joint agency of the four national societies of civil, mining and metallurgical, mechanical, and electrical engineers. He has represented the latter society on the Board of United Engineering Trustees since 1937.

This organization was founded by charter in 1904 "to advance the engineering arts and sciences in all their branches, to further research in science and engineering, to maintain a free public engineering library, and to advance in any other manner the profession of engineering and the good of mankind." It administers properties valued at more than $4,000,000, consisting of Engineering Societies Building, Engineering Societies Library, which is the largest strictly engineering library in America if not the world, and endowment funds of the Engineering Foundation, the research organization of the engineering societies.

Other officers elected include Arthur S. Tuttle, consulting engineer as vice-president and treasurer, Charles E. Stephens, vice-president of Westinghouse Electric and Manufacturing Company, as vice-president and chairman of the Finance Committee, W. D. B. Motter, Jr., assistant to the vice-president of the Chile Exploration Company, as assistant treasurer. John H. R. Arms, member A.S.M.E., general manager of the Corporation, continues as secretary.

American Welding Society Elects Officers

DURING its 24th Annual Meeting The American Welding Society elected David Arnott, American Bureau of Shipping, New York, N. Y., president for the year 1943-1944. Isaac Harter, member A.S.M.E., vice-president, Babcock and Wilcox Co., Barberton, Ohio, and A. C. Weigel, member A.S.M.E., vice-president Combustion Engineering Co., Inc., New York, N. Y., were elected first and second vice-presidents, respectively.

Engineering Foundation Elects Officers

THE Engineering Foundation at its annual meeting on October 21 re-elected A. L. Queneau, metallurgist of the United States Steel Corporation, as chairman for the ensuing year. Kenneth H. Condit, member A.S.M.E., dean of engineering, Princeton University, was elected vice-chairman; Edwin H. Colpitts, formerly director of the Bell Telephone Laboratories, was re-elected director, and John H. R. Arms, member A.S.M.E., re-elected secretary.

The Research Procedure Committee will be composed of Dean Condit, E. M. T. Ryder, way engineer, Third Avenue Railway System; Prof. H. E. Wessman of New York University; W. M. Pierce, chief of the Research Division of the New Jersey Zinc Company; Prof. W. Trinks, member A.S.M.E., of Carnegie Institute of Technology; and Dr. W. A. Lewis of Cornell University. Mr. Queneau will represent the Engineering Foundation on the Executive Board of the National Research Council.

Thirteen researches, many of importance to war work were conducted during the year just closed covering the various fields of engineering. Several of these covered studies on soil mechanics and foundations; alloys of iron; rolling steel; furnace performance factors; insulating oils and cable saturants; welding; and educational projects.

Radio Engineers Elect Officers

THE Institute of Radio Engineers has announced the election of Hubert M. Turner, associate professor of electrical engineering, Yale University, as president of the Institute, and Ralph a Hackbusch, Research Enterprises, Ltd., Leaside, Ontario, as vice-president.

Directors elected for three-year terms are: Raymond F. Guy, National Broadcasting Company, New York, N. Y., Lawrence C. F. Horle, consulting engineer, New York, N. Y., and William C. White, General Eectric Company, Schenectady, N. Y.

Fisk to Head Wyoming Research Institute

APPOINTMENT of Dr. Henry G. Fisk as director of the newly formed University of Wyoming Research Institute has been announced.

The University of Wyoming Research Institute, which Dr. Fisk has headed since Nov. 1, 1943, is said to be the first institution of its kind in Wyoming. Operating in conjunction with the University, its purpose is to aid, by scientific research, in the discovery, development, and exploitation of the natural resources of the State.

The immediate work of the Research Institute will be centered about rapidly expanded development of strategic and critical materials to meet war needs, particularly in the rocks, minerals, ores, and fuels which Wyoming is providing, or can supply from her unexplored sources.

C. J. Mackenzie Awarded Sir John Kennedy Medal

THE president of The Engineering Institute of Canada, K. M. Cameron of Ottawa, has announced that the Council of the Institute had awarded the Sir John Kennedy Medal to Dr. C. J. Mackenzie, dean of engineering at the University of Saskatchewan, and acting president of the National Research Council at Ottawa. This medal is awarded, as the occasion warrants, for recognition of outstanding merit in the profession and of noteworthy contribution to the science of engineering.

Dean Mackenzie has been for the past thirty years a strong figure in western Canada before he came to Ottawa in 1939 to take over the direction of the National Research Council when Lieut. General A. G. L. McNaughton, honorary member A.S.M.E., was given command of the Canadian Army overseas. He is a noteworthy example of the broad-minded, public-spirited type of engineer of which so much has been written and heard in recent years.

In 1941 Dr. Mackenzie was president of The Engineering Institute of Canada. His outstanding contributions to the advancement of science have been recognized by Dalhousie University and McGill University which awarded him honorary doctor's degrees in 1941.

The Sir John Kennedy Medal will be presented to Dr. Mackenzie at the annual meeting of The Engineering Institute of Canada in Quebec City next February.

Del Mar Re-Elected Head of Engineering Societies Library Board

AT ITS meeting of October 21 The Engineering Societies Library Board re-elected as chairman for a term of one year W. A. Del Mar, chief engineer, Phelps Dodge Copper Corp., Habirshaw Cable and Wire Division, Yonkers, N. Y. Members of the executive committee of the Board, elected with Mr. Del Mar, are W. D. B. Motter, Jr., vice-chairman; E. F. Church, Jr., member A.S.M.E., Edward P. Hamilton, Thomas T. Reed, and George L. Knight, Fellow A.S.M.E.

The Engineering Societies Library Board, which administers the affairs of the Engineering Societies Library, New York, N. Y., is made up of three representatives each of the Four Founder Societies, the Director of the Library, Harrison W. Craver, who acts as the Board's secretary, a member of the United Engineering Trustees, Inc., three members at large, and, ex officio, the secretaries of the Founder Societies.

Representatives of The American Society of Mechanical Engineers are: A. R. Mumford, Combustion Engineering Corporation, New York, N. Y.; John Blizard, head of research department, Foster Wheeler Corporation, New York, N. Y., and E. F. Church, Jr., Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

A.S.A. Revises Code For Abrasive Wheels

THE American Standards Association has announced approval of an important revision of the Abrasive Wheel Safety Code. This is the first revision of this Code since 1935.

New sections have been added to keep pace with changes in the industry. Completely new rules have been written for mounted wheels. New speed rules have been drawn up for crankshaft-grinding, camshaft-grinding, and thread-grinding operations. While the basic speed tables remain the same, the Code has been carefully reviewed and many points have been clarified.

1943 A.S.T.M. Standards on Steel Piping Materials

THE 1943 edition of all of the specifications issued by the A.S.T.M. covering steel piping materials includes 44 standards and also provides 25 emergency alternate provisions that have been issued to aid in expediting procurement. Many of the specifications and emergency provisions are part of schedules appended to W.P.B. limitation order L211.

There are 10 specifications on boiler, superheater, and miscellaneous tubes. A number (16) cover various types of pipe; 5 cover still tubes for refinery service and heat-exchanger and condenser tubes, and 5 specifications widely used in the field of carbon-alloy-steel castings for valves, flanges, and fittings are also given. There are 4 specifications covering forgings and welding fittings. Of the 4 standards for bolting material, one is included for the first time covering heat-treated carbon steel. The book is complete with the austenite-grain-size classification chart for steels.

Copies of this publication can be purchased at A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia 2, Pa.

Gwynne Pump at Passaic Copper Mine, 1844

SIR William Tritton of Gwynne Pumps, Ltd., wishes information about a Gwynne pump that was supplied to the Passaic Copper Mine in 1844. If anyone has records of the pump or can suggest where such records may be found, will he please communicate with the Editor of MECHANICAL ENGINEERING?

General Campbell Expresses Appreciation

APPRECIATION of the article, "Redesigning the Machine-Gun Mount by the Industry-Ordnance Team," by Major C. D. Alderman, which appeared in the September issue of MECHANICAL ENGINEERING, has been expressed by Major General L. H. Campbell, Jr., Chief of Ordnance, in a letter to H. V. Coes, president A.S.M.E.

Five thousand reprints of the article were presented to the Ordnance Department for use in its "Tremendous Trifles" campaign, a notice of which appeared in the advertising section of the same issue and was used as the cover of the reprint.

General Campbell's letter to Mr. Coes follows:

MY DEAR MR. COES:

I have just had an opportunity to inspect the September issue of MECHANICAL ENGINEERING and specifically the three items mentioned in your letter of September 8th: Major Alderman's article on page 636, the editorial on page 624, and the colored advertisement on page 10.

Your Society and its members have always co-operated with the Ordnance Department in a splendid manner, but I particularly want to express my personal thanks for this latest evidence of its continuation.

The 5000 reprints which you were generous enough to furnish for use in the "Tremendous Trifles" program have already been widely distributed throughout the country and I do not doubt will be the means of obtaining many additional suggestions resulting in still further valuable conservation of critical materials, machines, and manpower.

Your assistance to the war effort is not only practical, it is also deeply appreciated by me personally.

Cordially yours,

L. H. CAMPBELL, JR.
MAJOR GENERAL, CHIEF OF ORDNANCE

Among the Local Sections

Synthetic Rubber Subject at Western Massachusetts

Walter Geldard Traces Developments in the Rubber Program to the Present Time

ON October 19 the Western Massachusetts Section held a dinner meeting at the Highland Hotel in Springfield with 75 members and guests present at dinner and 90 present at the meeting which followed. President Knight announced the election to membership in the Section of Messrs. Alfred N. MacLennon and George F. Long. Guest speaker of the evening was Walter Geldard of the U. S. Rubber Company, New York, N. Y., who spoke on "Developments to Date in the Synthetic Rubber Program." Mr. Geldard traced the history of rubber from the time of Columbus, when rubber came exclusively from South America, to 1839 when Goodyear started vulcanizing through the transportation of seeds from Brazil to England and Ceylon, to 1903 when the Ceylon rubber "came in;" to the application of organic chemistry in 1906, to 1941.

Going back to the late 1800's it was found that chemists were playing around with synthetic rubber but real developments did not occur until between 1921 and 1932 when Thiokol and Neoprene were produced.

The speaker gave the formula of crude rubber called Isopene and stated that this compound, as yet, had not been produced chemically. He named four so-called synthetics, Buna-S, called GRS, Neoprene, Buna-N, and Buta rubber which were involved in the present program, dealing at length with GRS which is the easiest to make, cheapest, and closest in characteristics to crude rubber, with the program calling for heavy production in the coming year.

In commenting on GRS, 50 per cent of the ingredients coming from alcohol and 40 per cent from petroleum, the speaker stated that with the use of carbon black a tire could be produced, which if driven at speeds under 35 mph, would last as long as our present tires, but high speeds with corresponding high temperatures would cause the breakdown of such a tire.

The other forms of rubbers were discussed, both from a chemical and use standpoint.

In his closing remarks Mr. Geldard stated that the problem was a long way from being solved and that civilians could not expect any synthetic tires for at least 12 months. He left his audience with the thought that unless the picture changes materially, the rubber companies would be only too glad to go back to using crude rubber as soon as possible. A spirited discussion followed Mr. Geldard's talk.

Beyond the Horizon at Akron-Canton

On October 15 the Akron-Canton Branch met and heard Arthur C. Horrocks, public relations department, Goodyear Tire and Rubber Company, speak on "Beyond the Horizon." Mr. Horrocks described how wealth, materials, and manpower have enabled the United States to become the world's principal producer of armaments. He pointed out solutions for some of the critical problems of management.

Radiant Heating at Baltimore by Harry K. King

On October 7 the Baltimore Section met at the Engineers Club when visitors and members heard Harry K. King, of the A. M. Byers Company, speak on "Radiant Heating as a New Trend in Space Heating." This was a joint meeting of the Engineers Club of Baltimore, Maryland Society of Architects, Baltimore Chapter of the A.I.A., and the Baltimore Section of the A.S.M.E. Radiant-heating installations using wrought-iron coils were reviewed. Different types of these installations in various structures were discussed. The high spot of the meeting was the spirited question period following the lecture.

On October 18 this Section heard Lieut. Col. L. C. McCabe speak on "Utility Activities of Army Installations." Colonel McCabe brought home the tremendous job confronting the post engineers at the various army camps. He touched on heating of living quarters which will take eight to nine million tons of coal in 1944 exclusive of gas, wood, and other fuels. The amount of water consumed has been reduced from 102 to 69 gallons per capita which is better than the record of most cities.

Combustion-Gas Turbines Subject at Boston

On October 14 the Boston Section met at the University Club. Two-hundred-and-twenty-five persons heard F. K. Fischer, member A.S.M.E., of Westinghouse Electric & Manufacturing Company, explain the combustion gas turbine and its possibilities as a prime mover. He described different types of gas-turbine cycles and compared their possibilities with the present steam cycles. After the lecture interesting discussions were given by Prof. L. S. Marks, Fellow A.S.M.E., of Harvard University, and Dr. Sanford A. Moss, Fellow A.S.M.E., of the General Electric Company.

Petroleum Shortage Subject at Bridgeport

On October 21 the Bridgeport Section met at the public library in Bridgeport when Dr. Benjamin T. Brooks, consulting chemist of Old Greenwich, Conn., spoke on "Is Our Petroleum Shortage Real?" Dr. Brooks is a former professor of chemical engineering and served as a manager in the chemical-warfare service in the last war. He was at one time chairman of the Committee on Petroleum Chemistry of the National Research Council. Many facts little-known to the layman were disclosed as well as the truth about the whole situation regarding oil supply. This Section recommends the speaker and subject to other Sections for complete enlightenment and education on grades of oil desired for specific purposes.

Photography Goes to War at Cleveland

On October 14 the Cleveland Section met at the Cleveland Engineering Society with a total of 100 members and guests to hear Harris B. Tuttle of the Eastman Kodak Company, speak on "Photography Goes to War." The lecture was illustrated and a motion-picture film was shown depicting the various types of colored pictures.

Agate for Knife Edges at Colorado Section

On October 21 the Colorado Section met at the Oxford Hotel in Denver, Colorado, to hear Gordon Clayson, superintendent of Wm. Ainsworth & Sons, discuss "Preparation of Agate for Balance Knife Edges." Mr. Clayson presented a most interesting description of the methods used in manufacture of precision balances, especially with regard to the use and preparation of agate for knife edges used in these extremely sensitive instruments.

East Tennessee Section Has Get-Together

East Tennessee Section met on October 14 and enjoyed a dinner at the S.&W. Cafeteria in Knoxville, Tenn. Informal talks were given and two General Electric movies were shown—"Excursions Into Science" and "Railroading."

Fort Wayne Section Hears R. M. McGee

Members of the Fort Wayne Section met on October 28 to hear R. M. McGee of the Jones-McLaughlin Corporation talk on "Manufacture of Wire and Wire Rope." Mr. McGee showed a film on wire and wire-rope manufacture. A running lecrure accompanied the film.

C. A. Powel Addresses Kansas City Section

At a joint A.I.E.E.-A.S.M.E. meeting on October 21, C. A. Powel of Westinghouse

Electric & Manufacturing Co., discussed "The Place of Laboratories in Equipment Development." Mr. Powel explained the important part laboratories have played in the development of our present equipment, including weapons for the United Nations. He described and illustrated with slides the East Pittsburgh laboratories of Westinghouse Electric & Manufacturing Company which are typical of large commercial laboratories.

Louisville Section Hears Dean Potter on Patent System

At a joint meeting of the Louisville Section with the American Chemical Society on October 14 an audience of 225 heard Dean A. A. Potter, Past-President, A.S.M.E., speak on "The Engineer and the American Patent System." He emphasized the necessity of a strong patent system to encourage the inventor and investor by its adequate protection. As the American patent system is essentially sound and adequate only minor changes in procedure are recommended.

Milwaukee Section Visits Nordberg Plant

On October 20 the Milwaukee Section met for dinner at the Dinner Bell Restaurant and then visited the Nordberg Manufacturing Company. This company has one of the best equipped heavy-machinery shops in the United States. Considerable new machinery has been added in the past three years for specialized operations such as turning large crankshafts, milling large frames and bedplates, and so on. The company, at the present time, is engaged practically entirely in defense work, the principal production being Diesel engines for propelling Maritime Commission cargo vessels, heavy rock and ore crushers, mine hoists, extrusion presses, and railway-train maintenance equipment. This company is also building uniflow steam engines for ships. The greatest interest was shown in the inspection of the newly developed nine-cylinder engine of a size and rating nearly twice as large as any previously produced by this concern.

Mechanical Metering at New Orleans

The New Orleans Section held its first meeting of the 1943-1944 year with an attendance of 59 members and guests. After the dinner, which was held at Armand's Restaurant, the audience heard W. W. Tomes of Cochrane Corporation, Philadelphia, Pa., speak on "Metering in the Mechanical Field." Mr. Tomes discussed particularly the flow-meter, giving theory and fine points of design. A number of exceptional installations were described.

North Texas Holds Two Meetings

On September 27 the North Texas Section enjoyed a 45-minute film "The Making of a Texan" which depicted the construction of training planes from the drafting board to finished product. On October 7 this Branch met to hear David C. Prince, member A.S.M.E., of the General Electric Co., speak on "Planning for Postwar Prosperity." Mr. Prince was president of the A.I.E.E. last year. He presented plans for postwar employment and illustrated his talk with charts and graphs showing the number of people engaged in all types of occupations for 1941 and 1943, and a projected victory (plus 2 years) along with the markets for all goods for the same years. "This was one of the most enlightening speeches heard in some time," was the comment of Section members.

After the War, What?—at Pittsburgh

The Pittsburgh Section met on October 5 at the Hotel William Penn. The guest speaker of the evening, Willard T. Chevalier, publisher of *Business Week*, gave a complete and studied analysis of postwar problems from the economic standpoint and each one's personal viewpoint. The problem of materials, money, markets, and manpower are going to continue to increase in complexity and our country is going to need alert guidance in order to retain the things for which we are fighting.

Shipbuilding and Arc Welding at Providence

The Providence Section met on October 5 to hear J. S. MacDonald, vice-president and general manager of the Walsh-Kaiser Co., Inc., speak on "Shipbuilding." The speaker outlined the construction of a ship beginning with the organization of the work and the planning and designing of the vessel. The various jobs were described and a progress chart was read, starting with the laying of the bottom shelf and ending with the application of the final coat of paint 23 days later. This Section met again on November 2 when it heard R. F. Wyer, application engineer of the General Electric Company, speak on "Modern Trends in Arc Welding." Mr. Wyer discussed the new a-c welding technique. He described the advantages gained by elementary magnetic blowing of the arc, the increase in welding speed and welding heat, and ability to accomplish deep fusion with more strength in the weld. He also discussed light-metal welding of aluminum and magnesium with helium-shielded equipment.

Raleigh Section Hears About Ventilation of Ships

The Raleigh A.S.M.E. Section held a joint meeting with the A.S.H.&V.E. on October 22 at Harvey's Cafeteria, Durham, N. C. The guest speaker of the evening, Commander T. H. Urdahl, spoke on "Ventilation of Ships." He stated that the ventilation of warships is essential for maintaining the highest efficiency of the working personnel. Over-ventilation means a reduction in armor weapons, speed, or range. This has made necessary a change from the old "rule-of-thumb" figuring to exact calculation. The number of ships involved has made standard sizes of equipment absolutely essential.

Photography Today at Rochester Section

On October 21 the Rochester Section heard Harris B. Tuttle, photographic engineer of the Eastman Kodak Company, speak on "Photography Today" which he illustrated with slides and motion pictures. There was an attendance of 200. Mr. Tuttle traced the use of photography in war from the Crimean war to the present time and described uses of photography in both training of recruits and in actual war operations, such as bombing, landing operations, detection of camouflage, and so on. Two movies shown demonstrated color photography and use of pictures of such types to teach history and other subjects by demonstration methods.

San Francisco Holds Three Meetings

The San Francisco Section met on September 23 to hear Major W. Doble speak on "The Prelude to War." Major Doble showed a feature-length film on this subject with additional remarks on the factors leading to the present war. The Professional Division Committee of the San Francisco Section held a luncheon meeting on October 21 at which time Dr. R. C. Shuey of the Bakelite Corporation gave a short talk on "Plastics as Engineering Material." Dr. Shuey discussed the element of plastics from the original Bakelite compounds to the present wide variety of plastic materials available. He showed typical samples of plastics as used for insulating material, gears, ball-bearing retainers, and other installations where plastic material has been used either for its mechanical or electrical property.

On October 28 this Section met to hear J. B. Perego and Captain A. B. Court, U.S.N. retired, speak on "Planning and Production Control." Mr. Perego discussed the technical aspects of production control including the co-ordination of plant activity with customer requirements. He outlined the basic requirements of the control system giving concrete examples of how it functioned in specific cases. Captain Court emphasized the importance of planning and production control, stating that it is a fundamental requirement for speedy victory and that will be of great value to industry when war production begins to taper off.

St. Louis Section Hears Col. M. H. Davis

The St. Louis Section held its October smoker at the Anheuser-Busch, Inc., Brewery as guests of Dr. Adalbert Von Gontard. Col. Merle H. Davis, Commanding Officer of St. Louis Ordnance District, was guest speaker. Colonel Davis began his speech by stating that the foundry industry, especially the malleable industry, has surged forward more in this war than any other industry. The steel-casting industry has also progressed considerably, especially since very thin sections can now be cast. However, Colonel Davis thought that the steel-casting industry was not very flexible for conversion purposes after the war since most of the shops are job shops, The development of nonferrous industries has declined in this war due to material shortages of brass, copper, and so on. Of course, the light alloys due to the development of the airplane industry were now predominant. However, Colonel Davis' contention was that aviation cannot consume all the aluminum capacity after the war because alloy steels and plastics will strongly compete with aluminum. He believed also that too many designs of machine parts have been put down as screw-machine products with the result that screw machines, especially Kingsburys, were now very plentiful. Therefore, because of their availability, screw-machine products would become dominant after the war since every endeavor would be made to use these machines.

Colonel Davis then described some of the forging machines used in producing high-explosive shell forgings. He concluded his speech by stating that since the manufacturers have been forced to adhere to close tolerances required in the manufacture of ordnance material the result would be better products after this war.

On October 22 Prof. Isaac Lippincott of Washington University addressed the St. Louis Section on "Economic Questions in Reconversion of Postwar Industry." Professor Lippincott discussed the economic phases of postwar industrial reconversion to peacetime activities. He explained renegotiation of contracts, cancellation of contracts, and financing of reconversion. The latter he considers the biggest problem, especially for small business.

H. L. Harvill Speaks on Die Casting at So. Calif.

On October 14 the Southern California Section met to hear H. L. Harvill, president of the H. L. Harvill Company, an outstanding engineer in the field of die casting, speak on "Die Casting—War and Postwar Applications." A 35-minute sound film preceded Mr. Harvill's talk, showing some of the latest developments in die casting. The speaker has been associated with the die-casting trade for many years.

Our World of Color at Waterbury

On October 26 the Waterbury Section met at the Hotel Elton where a talk was given by Norman F. Barnes on "Our World of Color." This lecture described the nature of color, color-mixture principles, color harmony, industrial application and control of color, and fluorescent and phosphorescent color. A large variety of apparatus and equipment was used for demonstration purposes.

Cooling Towers Progress at West Virginia

At a meeting held at the Daniel Boone Hotel, Charleston, W. Va., on October 26, L. T. Mart, president of The Malrey Company, Kansas City, Kansas, spoke on "Cooling Towers Progress." Mr. Mart, who is a well-known authority on cooling-tower design, traced the development of the cooling towers from the atmospheric deck-type tower with its excessive drift and loss of water to the modern induced-draft cross-flow mechanical cooling tower. L. B. McQuaid, the West Virginia's Section delegate to the Group V Local Section Conference, gave a report of the meeting held in Cincinnati. C. W. Obert, a member of the Metropolitan Section of the A.S.M.E., and a member of the A.S.M.E. Boiler Code Committee, gave a most enlightening report on his committee's activities.

W. H. Buch, personnel director of The Electro-Metallurgical Corporation, Alloy, West Virginia, spoke on training within industry as advocated by the War Manpower Commission. He described the various programs which are being used to train inexperienced employees in their jobs and, in addition, the aids which hard-pressed supervisors may use to help themselves to gain a better understanding of their problems.

Industrial Relations at Worcester Section

On October 8 the Worcester Section met to hear R. W. Stoddard and A. L. Wilkinson discuss "Industrial Relations." Labor relations, wage plans, labor unions, employee welfare, and related subjects were covered. Mr. Stoddard spoke on improvement of employee relations to avoid the need for unions and how to get along once a union is installed. Mr. Wilkinson mentioned some general difficulties which are experienced with unions and with union contracts.

Management Problems at Western Washington

The Western Washington Section met at the Gowman Hotel in Seattle, Washington, to hear Thomas S. McEwan, member A.S.M.E., speak on "Management Problems—Present and Future." This meeting was held in conjunction with a Group VII regional conference and all delegates were present. In addition to the speaker, a sound-slide film on "Steel Casting" was shown.

Junior Metropolitan Group to Meet December 14

On December 14, the junior group of the Metropolitan A.S.M.E. Section will be privileged to hear C. W. Gibbs of Ingersoll-Rand Company give a talk on "Compressed Air in Action." Mr. Gibbs is an experienced speaker and a recognized authority on the subject of compressed air. He has had many years with the compressor engineering department of Ingersoll-Rand Company and is the author of many articles. Some of his most recent papers are: "How to Get the Most From Compressed Air," *Factory Maintenance and Management;* "Why Allow Water in Compressed Air?" *Power;* and "Air Compressors, Their Selection and Application," *Pit and Quarry.*

An informal dinner will be served at 6 p.m. at the upstairs private dining room at Child's Restaurant, 109 West 42nd Street. ($1.00 per person.) It is hoped that a goodly number will attend and get acquainted with their fellow members.

With the Student Branches

Industrial Inspection Trip at Oregon

Military Report Quoted Verbatim

ON September 18 the OREGON STATE BRANCH of 44 A.S.T. students made an inspection trip to Albany, Oregon, and we quote J. E. Johnson's military report on this trip. Mr. Johnson is the Branch Secretary.

"1 Pursuant to authority granted September 3, 1943, by O.S.C. Student Branch A.S.M.E., forty-four student members and three faculty members proceeded this date (September 18, 1943) from Corvallis, Oregon, to Albany, Oregon, for purpose of inspecting plants of Albany Plylock Corporation, Mountain States Power Co., and Kurre Ice Company.

"2 Transportation was by government ve-

A.S.M.E. STUDENT BRANCH OF OREGON STATE COLLEGE

("Detrucking" for an inspection tour of industrial plants.)

CASE SCHOOL OF APPLIED SCIENCE STUDENT BRANCH OF A.S.M.E.
(Pictures taken for the "Differential"—Case Yearbook.)

hicle furnished by Motor Pool of A.S.T.U. 3900. Time and place of departure, 1330 hours from Men's Dormitory. Arrival at Albany Plylock Corporation at 1400 hours.

"3 Inspection of plant proceeded immediately with company officials acting as guides to four separate parties. In order of process of manufacture, the salient points covered by the inspection were the dragsaw cutting of logs in the water; the raising, debarking, and shaving of logs into thin sheets; the cutting, trimming, and sorting of the sheets; the drying ovens; the coating of sheets with blood glue and resin glue; the setting of the glue in the plywood panels by means of the high frequency induction presses, which is the outstanding feature of the plant; and finally, the sanding and packing for shipment of the finished plywood.

"4 Of especial interest were the large boilers and the steam-turbine-driven generator which provide the plant with power.

"5 Among the minor but impressive features of the plant were the circular saw blade sharpener with its various cams and kinematic motions, and the clever means of patching plywood.

"6 From the Albany Plylock Corporation the convoy proceeded to the Mountain States Power Co. plant. Upon detrucking, scouts reported the presence of a small store which immediately did a land-office ice cream and cold drink business.

"7 The advance of the detachment upon the power plant was temporarily halted by wire and a good strong padlock until Professor Hughes properly signaled the man in charge and presented the password of the day.

"8 Inspected at the power plant were the 450-horsepower Corliss Steam Engine of vintage 1906, the water-turbine-driven generators, and the centrifugal pumps supplying water for the city of Albany.

"9 The party next proceeded to the cold storage plant and in two groups inspected same from frozen prunes at 0 F to ice at 32 F. The machinery operating on the good old ammonia vapor refrigeration cycle came in for its share of attention and especially interesting was the method of manufacturing clear ice.

"10 The mission successfully accomplished, the Oregon State Branch of the A.S.M.E. entrucked at 1740 hours and returned to Corvallis, arriving at 1800 hours in time for chow."

California Branch Hears John Lindberg

On October 4 the CALIFORNIA BRANCH met to elect new officers for the next term. Chairman Austin Sanderson gave what was in effect a farewell speech and pep talk rolled into one. He then introduced the speakers of the evening, John Lindberg and Prof. L. M. K. Boelter, member A.S.M.E. Mr. Lindberg, an engineer with the Pan American Airways, described operational problems in air-transport service. Professor Boelter then gave a stimulating talk on the young engineer as a personality. In conclusion, Irwin Spitzer sounded an appeal for men to work on the magazine *California Engineer*. It seems that the magazine is suffering a man shortage and with all the "lovelies" cluttering up the California Engineer's office it's beyond comprehension how such a shortage of manpower can exist.

CALIFORNIA TECH BRANCH met on September 28 when films were shown on "The Magic of Steam." The films were followed by a short business meeting. This Branch held another meeting on October 6 at which Dr. W. H. Pickering gave a lecture on "Electronics." The speaker emphasized the increasing importance of electronic circuits to the mechanical engineer. The lecture was accompanied by an interesting demonstration of high-frequency radio.

Case Branch Holds a Victory Dance

CASE BRANCH held a Victory dance on September 25 after the Case Vs. Baldwin-Wallace football game. The dance not only publicized the A.S.M.E. but announced the opening of another football season. Attendance was excellent because of the post-game crowd and the dance was a boost to campus activities.

On October 27 CLARKSON BRANCH held its meeting. Dr. Eugene K. Falls, member A.S.M.E., made the suggestion that the student engineering branches at Clarkson be combined. The possible advantages of this would be larger attendance, better entertainment, and greater opportunities for securing good speakers.

COLORADO BRANCH met on September 30. The meeting was opened by Chairman Hutchi-

NEWARK COLLEGE OF ENGINEERING A.S.M.E. STUDENT MEMBERS

son. Prof. H. H. Kob of the mechanical engineering department gave a talk on his personal experiences as government construction engineer in Liberia, Africa, several years ago. This Branch held a joint meeting with the A.I.E.E. and A.S.C.E. on October 4. E. W. Nitschke, chairman of the A.I.E.E., presided. Prof. J. T. Strate, member A.S.M.E., presented an interesting discussion of some of the precautions to be taken while working in different fields of engineering. After the meeting the A.S.M.E. Branch acted as hosts to the combined group and served refreshments during a social hour.

Diesel Engines at Drexel

DREXEL BRANCH met on October 21 when a picture of the Branch members was taken for the "Lexerd," the school yearbook. Total membership to date has reached an all-time high of 135 members of which 63 are student members of the parent Branch and five are coed mechanical engineers. The staff of the Drexel A.S.M.E. Branch publication, *The Exhaust*, were complimented on their first issue. Much of the credit for its success was given to chairman Arthur Watkins, originator, and Wm. Hoch, editor. The guest speaker, Max Essl, chief consulting engineer for Baldwin Locomotive Works, spoke on "Diesel Engines." Following his talk, sound movies were shown illustrating the International Harvester Diesel. Prof. D. Dowell, member A.S.M.E., then gave a short talk emphasizing the importance to engineers of making an effort to overcome the universally prevalent and unwise practice of publicly "knocking" the organization to which they belong, whether it be school or industry. In conclusion an Atlantic Refining Company film, "Football Highlights of 1942" was shown.

UNIVERSITY OF ILLINOIS BRANCH held its first meeting of the semester on October 20 to elect new officers and discuss a membership drive to be held in the immediate future. Elections were as follows: Wm. W. Farnen, president; Fred L. Kahl, vice-president; Wilbur K. Banner, treasurer; and Edwin K. Sutherland, secretary. On October 27 this Branch met again when it enjoyed hearing H. W. Case, a representative of the Douglas Aircraft Corporation, describe two films "We Give Them Wings" and "Design for Flying." Five new members were taken into the Branch at this meeting.

IOWA BRANCH met on August 11 when it elected new officers for the coming quarter. President Perelman then introduced the speaker of the evening, Prof. C. T. Grace, member A.S.M.E., who spoke on "Vibration Characteristics of a V-8 Engine." This Branch held its first meeting of the fall quarter on October 4. The program followed a dinner especially arranged for A.S.M.E. members and mechanical-engineering faculty members. The speaker was Mr. Laube, vice-president in charge of engineering, Carrier Corporation. He was introduced by his old friend and teacher, Prof. R. A. Norman, member A.S.M.E. Mr. Laube, a graduate of the mechanical-engineering department of Iowa State College, told of his school days and of his experiences in industry. He spoke informally of his wide experiences and turned the meeting over to questions after his talk.

LOUISIANA STATE BRANCH invited fifteen initiates to its meeting on October 5, among them the newly elected president of the college of engineering. Chairman Chesson explained the purpose and advantages of the Branch. On October 28 this Branch met to make final plans for the banquet to be held at one of the Baton Rouge hotels in honor of the new members. Mr. Marion Moore, head of the Louisiana State University sugar factory, who has worked in Great Britain for many years, will be the guest speaker at this banquet.

MICHIGAN MINING and TECH BRANCH held its first meeting on October 8. Plans were made for suitable programs for meetings to come. A list of speakers and subjects was read by program chairman Ellerthorpe who stated that all speakers are available through the headquarters of A.S.M.E. in New York City. This Branch met again on October 19 when plans were made to hold a social gathering on November 2, with the purpose of recruiting freshman mechanical students and providing an opportunity for all to get acquainted. After plans were discussed each student told briefly of any connection he had in industry, i.e. any engineering connection, to find out if any members were able to give an interesting lecture on their experiences.

On October 12 fifty-one students and three faculty members of the MISSOURI BRANCH held a meeting at which the picture "The Sikorsky Helicopter" was shown, accompanied by a lecture on the same topic by Ira Cohn, student member. E. G. Moneymaker was elected vice-president of the Branch.

Newark Branch Holds Joint Meeting

The NEWARK BRANCH on October 8 held a joint meeting of the members of Student Branches of each of the professional student branches at the college—mechanicals, electricals, civils, and chemicals. This was the first meeting of its kind at this Branch and in view of its success more joint meetings will be held in the future. The civil-engineering group furnished the speaker, Harold Osborne, a past-president of the A.I.E.E., of the American Telephone & Telegraph Company. His subject was "The Conservation of Men and Materials in Wartime."

The N.Y.U. EVENING BRANCH held its meeting on September 28. A cordial welcome was extended to all new members and the chairman urged all present members to obtain new recruits to make the coming year at least equal to last year's membership.

NORTHEASTERN BRANCH met on October 5. The first part of the evening was devoted to a business meeting. A program for the remainder of the year was discussed and committees were named to make preparations for the annual banquet. Announcement was made that Prof. A. Whittaker, member A.S.M.E., the faculty adviser, had left temporarily to teach war courses at M.I.T. In the meantime, his duties will be assumed by Prof. Frederick A. Stearns, member A.S.M.E. At the conclusion of the business discussion, the speaker of the evening, Bernard Resnick, spoke on "Marine Lubrication," a subject familiar to him through experience gained while a co-operative student employed at the Boston Navy Yard. On October 7 a joint meeting of the A.S.M.E. and the Society for Advancement of Management was held at Northeastern University and an interesting film on "Tool Design and Time and Motion Study," was shown.

NORTH CAROLINA BRANCH held its first regular meeting this quarter on October 12. A new vice-president was elected, John Simmonds. S. L. Furches, Jr., was elected to be the alternate for the Engineers Council. The president announced a new program to bring a greater attendance to the meetings. Before the next meeting personal letters are to be written to all eligible freshmen and sophomores inviting them to the next meeting of the Branch.

On October 8 OHIO BRANCH held its first autumn-quarter meeting. Mr. Schwemler read an article from the Ohio State *Lantern* which described the senior mechanical engineers and their new head gear, the locomotive fireman's cap. Dr. I. J. Wang of the electrical-engineering department gave an interesting talk on "The Betatron." This Branch held its second autumn meeting on October 22.

CENTRAL INDANA SECTION OF A.S.M.E. MEETING AT PURDUE UNIVERSITY
(Engineers from all parts of Indiana attended the banquet held in conjunction with the Purdue Student Branch.)

The chairman introduced Dr. Hofstetter of the department of optometry who gave a fine talk on "Color Blindness."

On October 5 OKLAHOMA BRANCH met and elected new officers for the ensuing year. Discussion of the mechanical exhibit at the Thirtieth Annual Engineers' Open House followed and it was decided to have as many of the engines running as possible at this exhibit. New Army and Navy men on the campus were welcomed to the Branch and many transferred students were welcomed. A new faculty sponsor was chosen, Prof. E. F. Dawson, head of the mechanical-engineering department and an outstanding supporter of the Branch in the past. He replaces Prof. E. M. Sims, member A.S.M.E., who is now teaching at Oregon State College at Corvallis, Oregon.

PRATT BRANCH held its last meeting before graduation on October 13 for the election of new officers. They are Thomas Wardle, chairman; Christian John Umland, Jr., vice-chairman; Ralph J. Benes, Jr., secretary; and Andrew Dedicos, treasurer.

Development of Firearms at Purdue Branch

PURDUE BRANCH met on October 7 when 150 mechanical engineers representing industries in Indianapolis, Columbus, Kokomo, and Chicago, attended a joint meeting of the Purdue Student Branch and Central Indiana Section of the A.S.M.E. Forty of these engineers came from industries outside of Lafayette. The program consisted of an inspection trip through the research laboratories of the schools of mechanical engineering and aeronautical engineering, a dinner, and a program of demonstration lectures. J. T. Agnew spoke on "Stress Corrosion in Steels;" Dr. C. R. Freberg on "The Application of Electrical Models to the Solution of Vibration Problems;" Dr. W. L. Sibbitt on "The Shadow Method of Studying Convective Heat Flow;" and Mr. J. A. Hardy, on "The Measurement of High Frequency Pressures." The lectures were followed by a discussion period.

This Branch met again on October 20 when Mr. Elmer Waters interestingly traced the historical development of firearms. Mr. Waters, an amateur gun collector and secretary of the Tippecanoe County Historical Society, started out with the assertion that gunpowder was already known in China when Moses led the children of Israel from Egypt. Not until the Moors overran the Iberian peninsula, however, did Europeans know anything about that new killing powder. In the beginning the development was rather slow. Guns were clumsy and inaccurate. Even Gustaphus Adolphus still used such a monstrosity as a leather cannon, firing logs. In the last few centuries progress in rifle manufacture has been much more rapid. Germans led the development for many years.

A development parallel to that of the rifle may be found in the pistol. Somewhere along the way we may find pocket-size pearl-handle arms of no more than five inches in length or guns with six barrels, which may be fired consecutively. This whole subject was well illustrated by samples from the speaker's collection and his large store of anecdotes.

Captain Freel added a few words about the army rifle and then proceeded to show samples of some of the field gun ammunition now in use. He mentioned that, although the Garand rifle has been accepted as standard equipment, the Springfield and Enfield rifles are still in use for special purposes in the Army. Most of the guns now used are semiautomatic weapons, which means bullets are loaded automatically, but the trigger is pulled separately for each shot. Among the ordnance pieces exhibited, Captain Freel had shells ranging in size and purpose from the 37-mm armor-piercing shell with its blunt soft nose hiding the sharp point, to the 105-mm high-explosive shell with its shiny timing mechanism. Also included in the collection was one of the famous bazooka missiles.

RICE BRANCH met on September 1 to hear H. B. Madder, production engineer of Mission Manufacturing Co., Houston, Texas. He spoke of the manpower problem confronting production departments today stating that with the rapid turnover of labor, the normal percentage of scrap has necessarily increased. He predicted that the future of the engineer will be bright because there must always be a sufficient number of younger men to fill the places of the older men as they advance. On September 15 this Branch held another meeting to hear S. T. Sikes, Jr., of the Humble Oil and Refining Co., speak on "Drilling Problems," in which he discussed depth of well, casings, coring, drilling muds, and other phases of drilling operations. On October 6 this Branch met to elect new officers for the semester starting November 1.

RUTGERS BRANCH met on October 19 and inaugurated a new idea for the regular meetings, that of having leading juniors plan and conduct the meetings so that they will be in a position to take over the leadership when seniors graduate. The first special meeting was very successful. Ed Davis was the presiding officer and Nick Fillipone was the acting secretary. Samuel Goldfarb gave a demonstration of a small model airplane. After the talk, a film "Airflow" was shown.

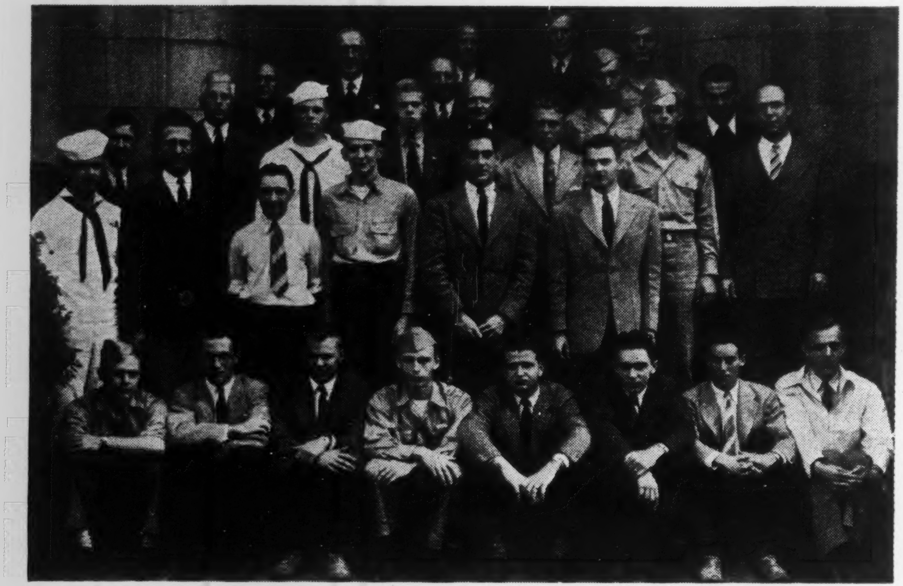
Amphibious Tanks at Santa Clara

On September 22 the SANTA CLARA BRANCH held its first meeting which was devoted to introducing the new freshman students and the enlisted men in the A.S.T.U. stationed at Santa Clara, to the A.S.M.E. Student Branch. Dean G. L. Sullivan, member A.S.M.E., pointed to the benefits a student of engineering derives from joining the Branch. On October 6 this Branch again met. The guest speaker was Richard Fox, an alumnus now employed by the Food Machinery Corporation, San Jose, Calif., Division, whose company is now engaged in the production of amphibious tanks for the Navy and Marine Corps. The talk was presented as a preview to an inspection trip through the plant which has been arranged with the Navy Department by the Student Branch of the A.S.M.E. Following Mr. Fox, the chairman announced that a program for the coming school year had been compiled and that this year would be one of the most active in the history of the Branch.

The regular meeting of the SOUTHERN METHODIST BRANCH was held on September 24 at the Fondren Library auditorium with 18 members and 8 visitors present. Preliminary plans were made for an engineering students' picnic to be held October 9. The guest speaker for the evening was David C. Pfeiffer, industrial engineer, Dallas Power & Light Company, Dallas, Texas, who gave a talk based on his paper "An Engineering Discussion of the Desiccation of Human Blood Plasma," which was presented at the 1943 Spring Meeting of the A.S.M.E. and published in MECHANICAL ENGINEERING for May, 1943, pp. 325–331.

Bridge Construction at Stevens

STEVENS TECH BRANCH met at the Hotel Plaza, Jersey City, N. J., on October 5 for a dinner meeting. Among those present were honorary chairman, Prof. K. J. Moser, member A.S.M.E., James R. Creese, vice-president of Stevens University, and Montgomery Case, well-known civil engineer, now retired, the guest of honor. Mr. Case kept the group entertained throughout the dinner by relating humorous and interesting anecdotes



CLASS OF 1944 SCHOOL OF ENGINEERING AT YALE UNIVERSITY
(Senior mechanical engineers and mechanical-engineering department faculty.)

from his checkered career in the engineering field. He told of many unusual incidents and facts concerning the construction of various bridges, such as the Philadelphia-Camden span, the George Washington Bridge, and the Outerbridge Crossing. After the dinner, four reels of film showing the construction of the George Washington Bridge, step by step, and one reel on "Leaping Lena" the Tacoma Bridge, were presented. Mr. Case obtained the first-mentioned four reels from the Port of New York Authority for the meeting and loaned the last reel from his own collection. This get-together was a successful start toward a busy year for this Branch.

The TENNESSEE BRANCH held a meeting on September 30. It was decided to retain present officers for the fall season and to elect officers for the winter session by written ballot. Honorary chairman, Prof. F. H. Thomas, spoke for the benefit of new members, stressing the advantages of belonging to the A.S.M.E. Student Branch. Chairman Balthrop provided information on opportunities for awards and suggested that some of the members try for them. This BRANCH held another meeting on October 13 to elect new officers for the winter session. James C. Hodges is the new chairman, John Kerr, vice-chairman, and Stanley C. Huddleston, secretary and treasurer. A movie "Railroading" was shown. At its October 28 meeting four A.S.M.E. nominees for the engineering-ball queens were elected: one from each class: freshman, Julie Dossett; sophomore, Betty Jane Hicks; junior, Mary Virginia Cross; and senior, Ira Pickens. Prof. F. H. Thomas showed an excellent collection of color slides which he had photographed in the national parks and other places of interest.

Texas Branch Holds Two Interesting Meetings

On September 27 TEXAS BRANCH held a business meeting, after which Robert Kidd showed three films. One was a government training film on the subject of the urgency of recognition of enemy and friendly aircraft instantly. The picture was entitled "The Jap Zero," and included all the distinguishing characteristics of that plane. The film illustrated graphically the danger of using hasty judgment in starting to "shoot before you're sure." The other films were "Football Thrills of 1942," and "Sunday in the Valley of Mexico," a travelogue. On October 11 this Branch again met to hear Mr. Young of Houston. Mr. Young is a graduate of the Oklahoma A.&M. and has been active in the field of metal spraying for many years. He has been instrumental in developing much of the equipment now being used in this industry. His talk was on "Metallizing," supplemented by a silent motion picture.

Correction

IN the October issue, page 755, a meeting of THE PENNSYLVANIA STATE COLLEGE BRANCH was erroneously credited to the University of Pennsylvania. The account should have read as follows:

Penn State Hears Helicopter Principles

On August 23 an audience of 300 students and townspeople enjoyed a lecture and film on the helicopter presented by THE PENNSYLVANIA STATE COLLEGE BRANCH. Albert Yackle, president of the Branch, sketched the life of the inventor Igor Sikorsky before presenting Boris Osijnak, a senior in aeronautical engineering. Mr. Osijnak, supplementing the aerodynamics film with explanations, described the principles behind the helicopter, and pointed out that the safety feature of the airplane is that of constant speed, reducing the possibility of stalling to an impossibility. A second film presented was a technicolor movie showing one of the first helicopters in the various stages of flight. Charles Duke, an aeronautical-engineering senior, described the future helicopter as an airplane traveling at more than 80 miles per hour, and costing no more than the average modern automobile. Credit for this successful meeting should be accorded Prof. John W. Oehrli, who did much toward its planning.

Metropolitan Section Hears Captain Manseau on Raising of the "Normandie"

SALVAGE operations on the U.S.S. *Lafayette,* former French liner *Normandie,* which capsized at her mooring, Pier 88, North River, New York, N. Y., on Feb. 9, 1942, as a result of flooding caused by attempts to extinguish a devastating fire, were outlined to the Metropolitan Division, A.S.M.E., at a meeting held in the Engineering Societies Auditorium, New York, N. Y., on Navy Day, Oct. 27, 1943.

Capt. B. E. Manseau, U.S.N., officer in charge of Ships Salvage Branch, of the Bureau of Ships of the Navy, who carried the responsibility of directing the salvage operations, was the principal speaker on this occasion. His address was followed by the showing of an intensely interesting Navy motion picture covering the many features of the salvage work.

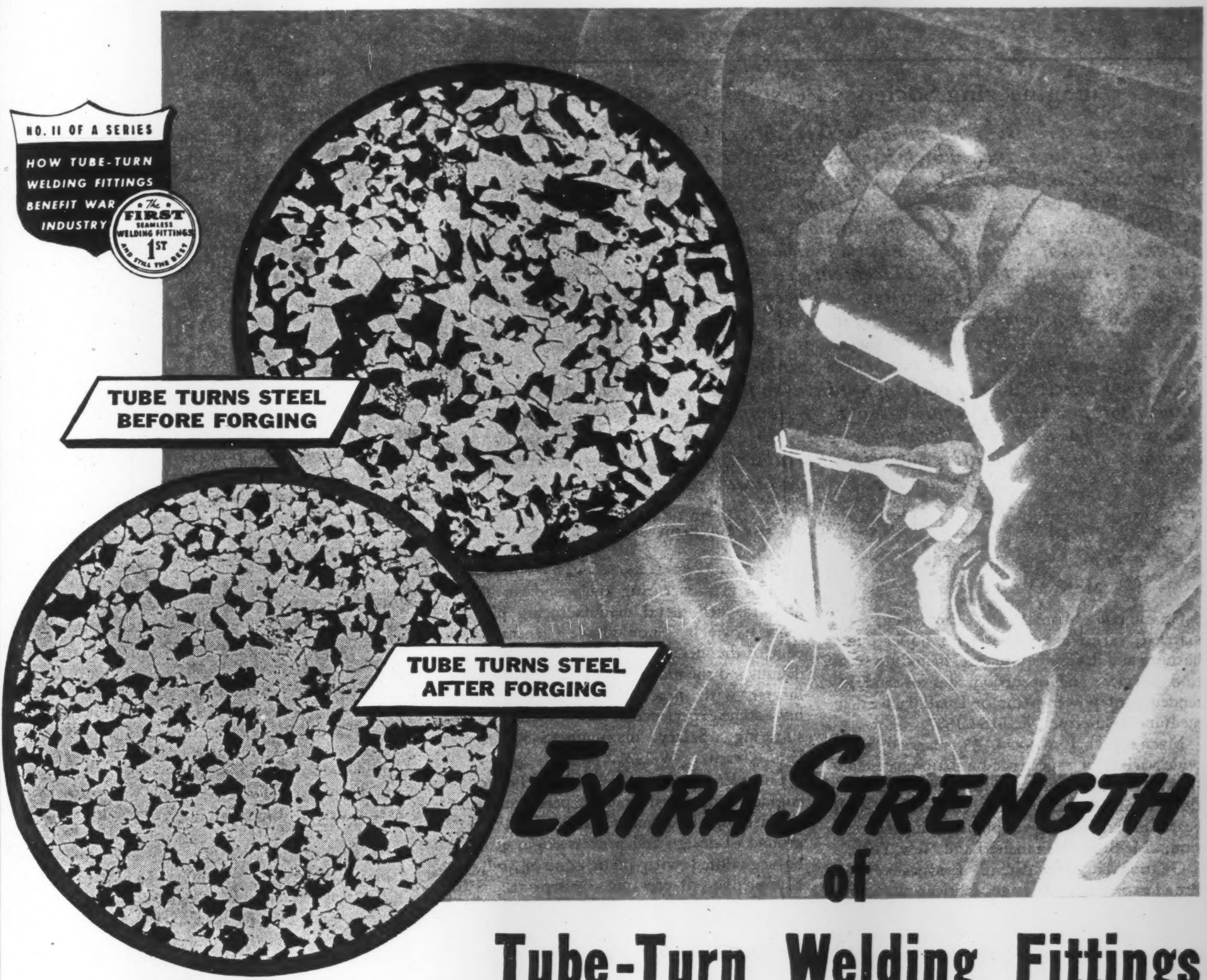
Capt. John I. Tooker, superintendent of the operations, representing Merritt, Chapman, and Scott, the company which conducted the actual salvage work, was also present and spoke briefly and informally at the conclusion of the showing of the motion pictures.

Harold V. Coes, president A.S.M.E., presided at the meeting, which was jointly sponsored by the Metropolitan Section and the Society of Naval Architects and Marine Engineers. F. P. Brand, of the A.S.M.E. Metropolitan Section, was in charge of arrangements of the meeting.

So popular was the subject presented by Captain Manseau that every available space in the Auditorium was occupied, doors and aisles were crowded with standees, and several hundred persons were turned away.

A brief account of some of the principal factors involved in the salvage operations appeared in the November, 1943, issue of MECHANICAL ENGINEERING, pages 814–815. It is hoped that Captain Manseau's paper will be published in a later issue.

(*A.S.M.E. News continued on page 938*)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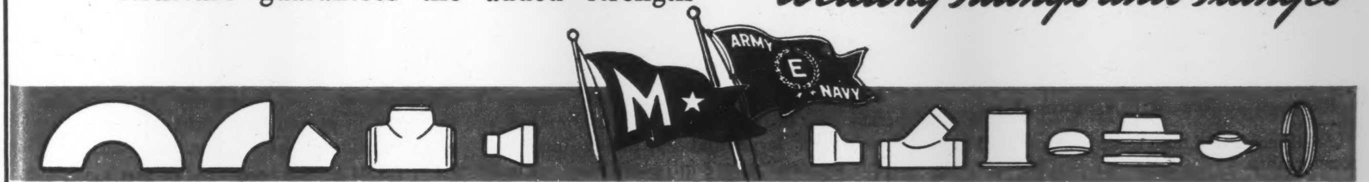
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ARMY E NAVY

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient, nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York 8 West 40th St.
Boston, Mass. 4 Park St.
Chicago 211 West Wacker Drive
Detroit 100 Farnsworth Ave.
San Francisco 57 Post Street

MEN AVAILABLE[1]

Graduate Mechanical Engineer, 41, married; varied experience with boilers, fuel burning and drying equipment, including erection, service, and operation, desires superintendency of power plant or small factory in medium-sized city. Me-818-C1587.

Mechanical Engineer, 35, married; with wide variety of experience on maintenance design and construction, and flow-meter installation calculation and repair. One and one-half years' experience power-plant piping fabrication. Me-819-San Francisco and New York.

Graduate Mechanical Engineer, 44. Broad experience in design, fabrication, operation, maintenance, repair, and inspection of boilers, pressure vessels, and piping in industrial, municipal, and public-utility plants. Over ten years in operation, maintenance, and inspection turbines, reciprocating machinery, and power-plant equipment as engineer and casualty-insurance inspector. Seeks opportunity to put this experience to maximum use as chief engineer or other suitable supervisory work. Me-820.

POSITIONS AVAILABLE

Plant Superintendent with experience with type of heavy equipment used in quarries, clay operations, lime plants, mines, or heavy construction. Cement manufacturing experience desirable, not necessary. Apply by letter stating experience, draft status, reason for leaving previous employer and previous salaries received. Salary, $4200–$4800 a year. Michigan. W-2884D.

Mechanical Engineer to design tools, to supervise and check their drafting, and to follow engineering developments through the plant in conjunction with production. Attractive postwar outlook. Northern New York State. W-2897.

Chief Industrial Engineer who understands all phases of industrial engineering and is familiar with job evaluation. Will be in charge of industrial engineering in all of company's plants. $10,000–$12,000 a year. Headquarters, New York State. W-2914.

Process Engineer with a thorough knowledge of manufacturing and standard methods used in such metal manufacturing plants as specialty steels. Should have a general knowledge of the metallurgy of tungsten and molybdenum and the nickel-steels. Must be a metallurgist with practical experience. Should have some experience in power metallurgy and sintering. Salary, maximum $4800 a year. Pennsylvania. W-2921.

Chief Engineer, over 40. Must be graduate engineer with considerable experience in plant-engineering department. Should have background of design and process engineering and be acquainted with plant control and costs. Knowledge of ceramics essential. $5000–$10,000 a year. Permanent. New York, N. Y. W-2934.

Design Engineers for program to cover development for postwar production on nationwide basis. Applicants should have at least five years' experience in general machine design and those with experience in machinery related to canning, packaging, and processing of foods will be given preference. Salary open. California. Various divisions of the company throughout the United States. W-2941BCDS.

Chief Engineer for application engineering department, which designs Diesel-driven power units, using as component parts products of subsidiary companies, as well as companies outside organization. Duties will be to supervise the work of department, advise, and supervise project engineers on all questions of designs, supervise building of pilot models and tests thereon. Will consider person with good experience in designing and building Diesel-driven power units. $8,000–$12,000 a year. New York, N. Y. W-2943.

Production Manager to head department in which his immediate assistants would be production engineers, expediters, shop superintendent, and shop foremen. Duties would be careful planning of materials flow from various vendors to stores and from stores to production floor. Must have good engineering experience, preferably in Diesel-driven power units, or in assembling of middle-size machinery. $10,000–$12,000 a year. New York, N. Y. W-2944.

Assistant Chief Engineer with broad experience for heavy chemical plant. Important position in large and expanding industry. Apply by letter giving full particulars, including references and salary desired. Northern Ohio. W-2946D.

Industrial Engineer to take charge of time-study department. Must have had some previous supervisory experience and preferably knowledge of Bedeaux system. $5500 a year. New York, N. Y. W-2949.

Mechanical or Electrical Engineer, 30–45, graduate with background in selling or commercial line to be used at present obtaining subcontracts and in general customer-control work. Position will eventually lead into sales on postwar work. $4000 a year. New York, N. Y. W-2950.

Methods Engineer to do process engineering work in manufacture of electronic equipment. $5000 a year. New York, N. Y. W-2951.

Cost Estimator, preferably with some experience in electronic-equipment manufacturing field. Must be able to estimate cost and manufacture, including costs on parts and materials. $5000 a year. New York, N. Y. W-2952.

Industrial Engineer for management company on industrial surveys and installations, i.e., cost systems, standards, and incentive plans. $5000–$8000 a year. New York, N. Y. W-2953.

Graduate Mechanical Engineer, over 38, to represent company in territory. Will act as field-service engineer maintaining customers' contacts and servicing mechanical testing equipment. Men required for state of Indiana and northern New York State. Permanent. Salary open. Interviews, New York, N. Y. W-2959.

Master Mechanic, older man with technical training preferred. Should have had considerable experience in general chemical-plant construction and maintenance and be able to supervise all mechanical and electrical work. Permanent. To $4200 a year. New York State. W-2969.

Superintendent, not over 45, for medium-sized brass foundry in eastern city. Company well-established in brass valve work. About $6500 a year. Permanent. W-2977.

Estimator and Process Engineer with excellent experience in precise light machine-shop operations, to estimate costs, set time standards on the processing of parts for job shop work. $6000–$7500 a year. New York, N. Y. W-2985.

Design Engineer. Must be college graduate, with six to ten years' experience. For development and research work, preferably in aeronautical, automotive, and small high-speed Diesel-engine manufacture. $6500–$7500 a year. Permanent. Northern New Jersey. W-2990.

Assistant Plant Superintendent, 32–38, to supervise plant personnel in assembly of small parts. Should have had some previous experience in directing workers. $4200–$5200 a year. Permanent. New York, N. Y. W-3003.

General Superintendent of Assembly. (*a*) Must be experienced in precision assembly work such as small intricate machined parts, cameras, instruments, or the like. $7500–$8000 a year. (*b*) Assistants or departmental superintendent with such experience. $6500–$7000 a year. New York, N. Y. W-3004.

Engineers. (*a*) Production Manager experienced in planning operations, time study, and wage incentives, on precision machinery

(*A.S.M.E. News continued on page 940*)

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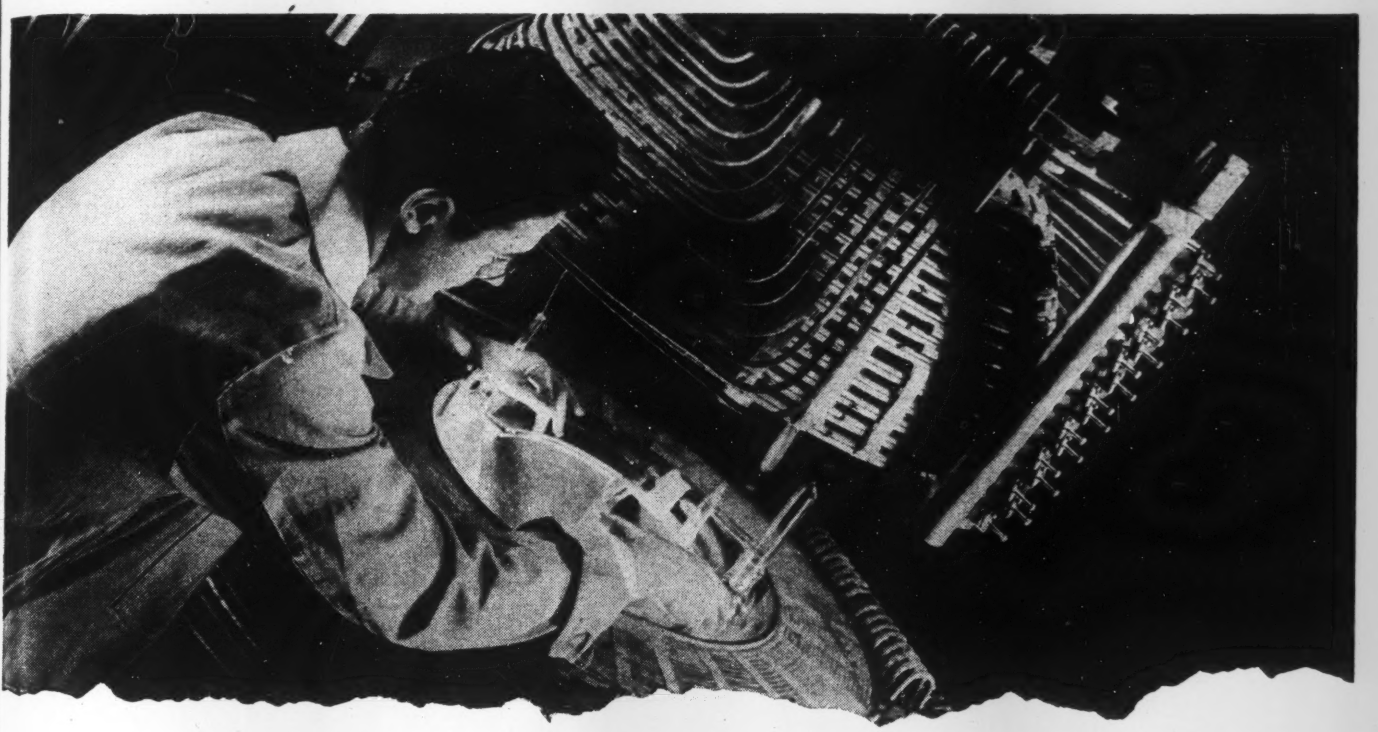
[1] All men listed hold some form of A.S.M.E. membership.



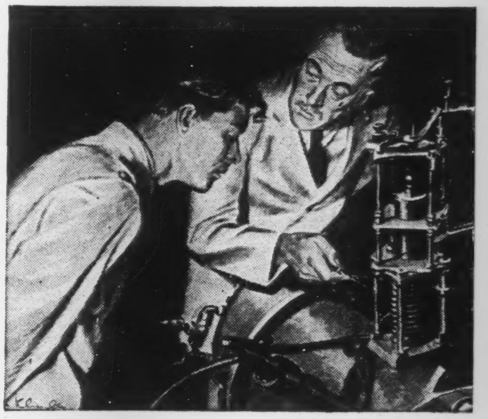
Helping the tire maker: Pictured here is a laboratory model of the new Westinghouse-developed "mass spectrometer," an adaptation of which analyzes gases with incredible swiftness and accuracy. Right now, one of the most important of its many uses is speeding up tremendously a step in the making of synthetic rubber.

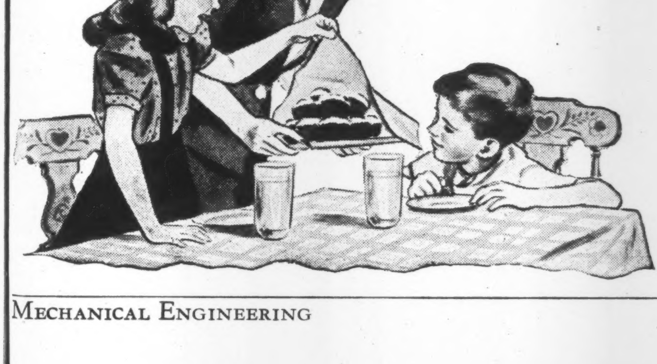
Westinghouse research accepts every wartime challenge . . .

Under the spur of war, Westinghouse research is delving into numberless mysteries, not only in the vast field of electricity and electronics, but also in chemistry, physics, metallurgy, plastics. And as a result, out of the great Westinghouse laboratories has come a steady stream of new war products, and new and better ways of making old ones.

Westinghouse research develops new talent for America . . .

To Westinghouse, each year, come several hundred budding scientists and engineers—to work, to learn, to blaze new trails in electrical research. And each year, through more than 100 Westinghouse scholarships, young men enter America's engineering colleges to develop the native skill and talent that have made America great and will make it greater.





Westinghouse research promises new wonders for peace . . .

You have heard much talk of the marvels science will offer you after the War. Well, there *will* be marvels—plenty of them—and Westinghouse research is working to contribute its full share. But we will never lose sight of what we consider our first duty: seeing that, beyond all question, each Westinghouse product, old *or* new, is the very finest of its kind. Westinghouse Electric & Manufacturing Co., Pittsburgh, Pennsylvania. Plants in 25 cities, offices everywhere.

work. $8500–$10,000 a year. (*b*) Assistant production engineers with similar experience. $7000–$7500 a year. New York, N. Y. W-3005.

Plant Manager, preferably graduate in business administration or mechanical engineering, 35–45, for management of packaging plant located within commuting distance of New York, N. Y. Should have had a well-rounded experience in plant management, including knowledge of personnel, industrial relations, and purchasing. Holds splendid opportunity for engineer with vigor and farsightedness to visualize and supervise modern plant management. Permanent. $6000–$8000 a year. W-3006.

Engineer with some experimental or development experience to analyze and improve machinery and mechanical processes in concern's manufacturing plants. Should have sound knowledge of mechanics, dynamics, thermodynamics, and materials, and some creative and inventive ability; these are more important than extensive production, design, or power experience. Permanent. Salary open. Western Massachusetts. B-332.

Candidates for Membership and Transfer in the A.S.M.E.

The application of each of the candidates listed below is to be voted on after December 27, 1943, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

Adams, J. W., Dallas, Tex. (Rt)
Andersen, Edward A., Yeadon, Pa.
Armstrong, Chas. A. N., Omaha, Neb.
Barba, C. E., Norwood, Pa. (Rt)
Benedict, Fred, Bremerton, Wash.
Bennett, Douglas W., Norfolk, Va. (Rt)
Bennett, H. D., Toledo, Ohio
Benns, J. J., Chicago, Ill.
Berg, Lothar E., New Orleans, La.
Berndt, Paul, New York, N. Y.
Birmingham, M. A., Minneapolis, Minn.
Blanchard, W. B., Newport News, Va.
Bloedorn, Chas. W., Wauwatosa, Wis.
Bursack, Wm. W., Fitchburg, Mass. (Re)
Cameron, Hugh C., Omaha, Nebr.
Carmichael, Jas. T., Shreveport, La.
Clark, Chas. J., Chicago, Ill.
Clark, Eugene G., Yonkers, N. Y.
Clayson, G. S., Denver, Colo.
Cook, Chas., Philadelphia, Pa.
Crawford, W. F., Chicago, Ill.
Crossley, F. R. E., Detroit, Mich.
DeLuca, Joseph A., Jr., Wilmington, Del.
Dodge, Robt. M., Montgomery County, Pa.
Dykhuizen, H. M., Fort Wayne, Ind.
Ellis, J. G. E., Shelton, Wash.
Elrod, H. G., Jr., Annapolis, Md.
Ely, Robt. E., Bakersfield, Calif.
Ferguson, Morris S., Salt Lake City, Utah
Foody, John J., New York, N. Y.
Fox, Robt. B., Alameda, Calif.
Fried, Anthony, New York, N. Y.
Gellman, Chas., North Bergen, N. J.
Gill, Thos. T., East Los Angeles, Calis.
Golem, G. C. W., Branford, Conn.
Gusler, Denard L., Morgantown, West Va.
Hall, Albert E., Birmingham, Ala.
Hammer, Alexander, Trenton, N. J.
Harvill, Henry L., Anaheim, Calif.
Hebrank, Eugene F., Hyattsville, Md.
Herkimer, Herbert, New York, N. Y.
Hovey, Otis W., Pittsburgh, Pa.
Hunt, Myron C., Hagerstown, Ind.
Hutton, Frank E., Chevy Chase, Md.
Johnson, Harold A., Oakland, Calif.
Johnson, Walter A., Ithaca, N. Y.
LaClair, Darwin J., Brooklyn, N. Y.
Lawrence, Hewson (Lieut.), Pasadena, Calif.
Le Gates, F. E., Cleveland, Ohio
Lewis, Oliver K., Jr., Oak Ridge, Tenn.
Lincoln, W. C., East Orange, N. J.
Linden, Berthold A., Long Beach, N. Y.
Malany, Herbert S., Cincinnati, Ohio
McCann, Chas. S., Racine, Wis.
Metz, Geo. W., New York, N. Y.
Moreland, W. B., New Orleans, La.
Morgan, Harry T., Philadelphia, Pa.
Morrell, Milton C., Trenton, N. J. (Rt)
Nantz, Merle E., Albany, Calif.
Onuf, Bronis R., Storrs, Conn.
Pascual, Santiago J., Brooklyn, N. Y.
Paton, A. Hugh, Montreal, Que., Canada
Peiffer, Harold E., Utica, N. Y.
Peirce, A. W., Buchanan, Mich.
Perriton, D. E., Toronto, Ont., Canada
Pohl, Richard G., New York, N. Y.
Price, Saml. R., Jr., New York, N. Y.
Reed, Daniel R., Philadelphia, Pa.
Robertson, Wm. T., Houston, Tex.
Roushey, Ray E., Westover, Pa.
Rouy, August, New York, N. Y.
Sandowski, W., Brooklyn, N. Y.
Sealey, Philip T., Dayton, Ohio
Shirer, Chas. C., Long Island City, N. Y.
Smalis, I. A. (Lieut.), Berlin, N. H.
Smith, S. Arnold, Newington, Conn.
Sparkes, Harry P., Newark, N. J.
Stehman, Fredk. F., Brooklyn, N. Y.
Straus, Ferdinand N., Fort Worth, Tex.
Sturm, Geo. W., Takoma Park, Md. (Rt & T)
Sundell, Saml. S., Minneapolis, Minn.
Streamer, A. C., Pittsburgh, Pa.
Swarr, J. N., North Woodbury, Conn.
Sutherland, Robt. L., Chicago, Ill.
Swengel, Franklin M., Avondale, Ariz.
Tannehill, V. L., Fort Wayne, Ind.
Taylor, Jerome J., Detroit, Mich.
Thomason, Jos. A., Memphis, Tenn. (Rt)
Throckmorton, Edmund H., Rock Island, Ill.
Thurstin, H. A., Jr., Lester, Pa.
Trawick, J. G., Birmingham, Ala.
Underwood, J. Bruce, Toronto, Ont., Canada
Vogtsberger, Arthur, Toledo, Ohio
Walker, T. H., Merion, Pa.
Wang, T. S., New York, N. Y.
Weierich, A. G., Lima, Ohio
Wilson, Wm. A., Jeannette, Pa.
Wolff, Richard A., Washington, D. C.
Wuest, Frank W., Barksdale, Wis. (Rt & T)

CHANGE OF GRADING

Transfers from Member

Hollins, Geo. G., Montclair, N. J.
Klein, A. C., Boston, Mass.

Transfers from Junior

Bartram, Paul R., Kenmore, N. Y.
Erickson, Edw. A., Terre Haute, Ind.
Falk, Melvin L., Wichita, Kans.
Garden, Jos., Mamaroneck, N. Y.
Geiger, W. C., Williamsport, Pa.
Kuffenheimer, John D., East Orange, N. J.
Laiming, H. J., Camden, N. J.
Rightmire, Brandon G., Cambridge, Mass.
Smith, Beauchamp E., York, Pa.
Southmayd, C. G., Toronto, Ont., Canada
Stoessel, R. F., Glendale, Calif.
Thomas, A. E. (Lt. Comdr.), South Ozone Park, N. Y.
Waring, R. W., South Orange, N. J.
Willis, Richard L., Bethlehem, Pa.
Wood, Wallace D., Rochester, N. Y.

Necrology

The deaths of the following members have recently been reported to headquarters:

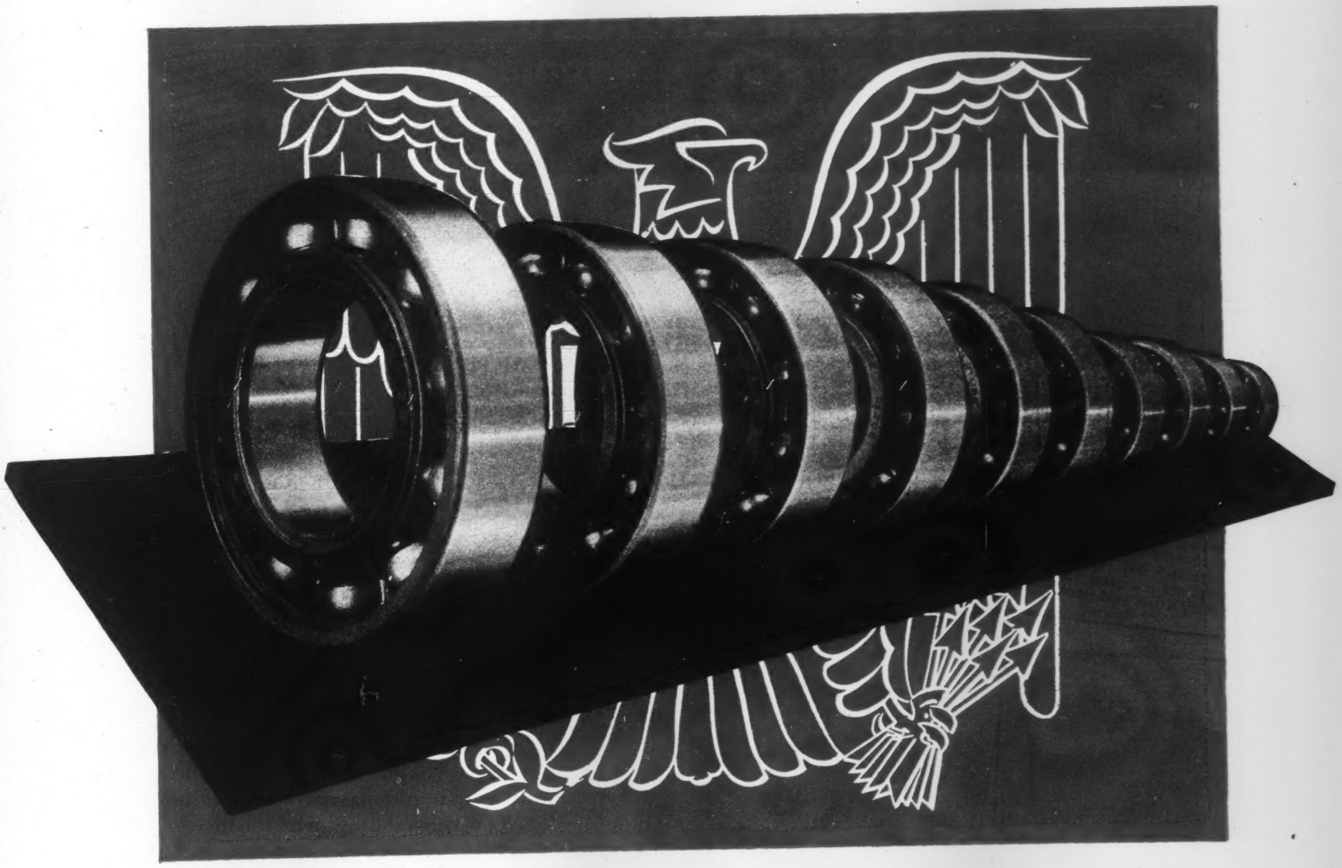
Bryson, Tandy A., August, 1943
George, Jerome R., November 1, 1942
Goetz, Victor J., November 24, 1942
Green, William O., October 25, 1943
Ladd, George T., October 3, 1943
Madsen, Sern, October 23, 1943
McClelland, Edward S., June 26, 1943
Wagner, James J., January, 1942

A.S.M.E. Transactions for November, 1943

The November, 1943, issue of the Transactions of the A.S.M.E. contains:

Automatic Temperature-Recording Control System, by M. E. Moore
Mechanics of Sheet-Metal Bending, by William Schroeder
Lignite—Influence of Storage Conditions Upon Size Degradation, Size Stability, and Friability, by C. J. Eckhardt, Jr., and C. W. Yates
Drying Characteristics of Vegetables—Riced Potatoes, by A. H. Brown and P. W. Kilpatrick
A Thermal Anemometer for Low Velocity Flow, by R. A. Seban, W. H. Hillendahl, E. J. Gallagher, and A. L. London
Investigation of Large Diesel-Engine Wrist-pins, Pistons, and Crankcase Explosions, by F. E. Faast
Proposed Expressions for Roots' Supercharger Design and Efficiencies, by F. A. Hiersch
Portable Oil-Well Drilling and Servicing Equipment, by James Moon
Theory of the Expanding of Boiler and Condenser Tube Joints Through Rolling, by A. Nadai
Fatigue Characteristics of Rubber, by F. L. Yost

New Departure
BALL BEARINGS



ON EVERY BATTLEFRONT

—keeping them flying, rolling, moving . . . not only at every point where shafts turn, where motion must be friction-free . . . but also where maintenance operations must be kept at a minimum.

3216

Nothing Rolls Like a Ball

ECHANICAL ENGINEERING, December, 1943, Vol. 65, No. 12. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial nd Advertising departments, 29 West 39th St., New York 18, N. Y. Price 75c a copy, $6.00 a year; to members and affiliates, 50c a copy, $4.00 a year. Postage to Canada, 75c additional, to foreign ountries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the act of March 3, 1879. Member of the Audit Bureau of Circulations.

In Practically Every Industry

SKINNER "UNIVERSAL UNAFLOW" STEAM ENGINES

are generating economical, dependable electric power

FURNITURE MANUFACTURER

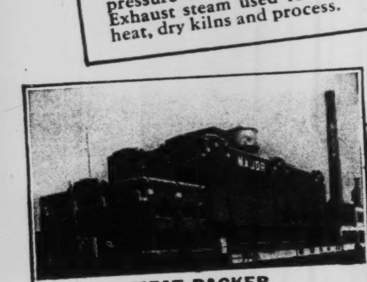
Well-known furniture manufacturer in Wisconsin. One 2-cylinder vertical "UNIVERSAL UNAFLOW" Steam Engine, with 625-kv.a., 3-ph., 60-cy., 240-v. A-C generator, belted exciter. Steam pressure 140-150 psi., sat.; back pressure 0-5 psi. Installed 1937. Exhaust steam used for building heat, dry kilns and process.

ADVERTISING SPECIALTIES

Nationally-known manufacturer of advertising specialties. Two horizontal and one 2-cylinder vertical "UNIVERSAL UNAFLOW" Steam Engines, with 250-v. D-C generators, 1450 kw. total capacity. Installed 1922, '26, '43. Steam pressure 165 psi., 90° F. s. h., 3 psi. back pressure.

MACHINE TOOLS

Well-known machine tool manufacturer in Cincinnati, Ohio. One 4-cylinder vertical "UNIVERSAL UNAFLOW" Steam Engine, driving 600-kw., 3-wire D-C generator and 500-kv.a., 3-ph., 60-cy., 480-v. A-C generator. Steam pressure 155 psi., sat.; back pressure 0-5 psi. Installed 1941.



MEAT PACKER

Prominent meat packer in Indiana. One horizontal "UNIVERSAL UNAFLOW" Steam Engine, with 375-kv.a., 3-ph., 60-cy., 480-v. A-C generator. Steam pressure 175 psi., sat.; back pressure 0-5 psi. Installed 1928. Exhaust steam used for building heat and process.

TEXTILE SPECIALTIES

Large textile plant in Ohio. Two horizontal "UNIVERSAL UNAFLOW" Steam Engines of 450 kw. total capacity, with two 125-v. D-C generators and one belted A-C generator. Steam pressure 120-150 psi., sat.; back pressure 0-3 psi. Installed 1916 and 1937. Exhaust steam used for building heat and process.

MORE than 2,000 power users, in industries and institutions of various types, have found it more economical to generate their own electric power with Skinner "Universal Unaflow" Steam Engines than to purchase power from the local utility.

The outstanding performance of "Universal Unaflow" engines has demonstrated the truth of our claim that they are "the most economical steam engines built." Their high economy is *permanent*—maintained throughout the life of the engine. Scores of installations have been paid for out of savings in fuel, or in comparison with purchased power.

Long life is another inherent quality of Skinner engines. Many of them have been operating twenty-five years or longer. In fact, the first poppet-valve unaflow engine produced in the United States was built by Skinner Engine Company in 1913 and is still in operation.

Although you may have a seemingly low *rate per kilowatt-hour* for purchased power, it will pay you to investigate, for postwar planning, how much lower your *cost* will be for power generated by Skinner "Universal Unaflow" Steam Engines.

Our production facilities, at present, are devoted entirely to building Skinner Unaflow Steam Engines for the war program

ARMY E NAVY

Proudly we fly the
Army—Navy "E" Flag,
awarded for
excellence in production

Our Seventy-fifth Anniversary
1868 – 1943

Back The Attack—With War Bonds

SKINNER ENGINE COMPANY FOUNDED IN 1868 **ERIE, PA.**

Round and 'round it goes

OILGEAR

Trademark Reg. U. S. Pat. Off.

this rotary casting
chine Oilgear Fluid
wer solved 4 diffi-
design problems.

and where it stops
only Oilgear knows!

ONE of the many places in which Oilgear Fluid Power has been applied to solve long-standing power application problems has been on the drives of paper-making machines. Here it has provided the means of closely synchronizing many motions so that the fragile web of paper under manufacture can be handled at much higher speeds without rupture.

Oilgear Fluid Power has supplied the now-it-can-be-done happy ending to many another long story of getting machinery to do the seemingly impos-ible. Among the many functions it provides are steplessly variable speed control of a moving member . . . traverse and return at different speeds . . . synchronizing of intricate sequences or cycles . . . a combination of straight-line and rotary motions.

It is almost certain you will find a solution to *your* design problem in the versatility of Oilgear Fluid Power and the long experience of Oilgear Engineers with hundreds of companies building machines and mechanisms of widely diversified use. *Now* is the time to find out. The Oilgear Company, 1307 W. Bruce Street, Milwaukee, Wisconsin.

ARE YOU TRYING TO:

1. Apply large forces through long . . . or short . . . strokes at variable speeds?
2. Obtain automatic work cycles, variable speeds in either direction . . . with or without pre-set time dwell?
3. Apply large forces through continuous or intermittent reciprocating cycles at constant or variable velocities?
4. Obtain extremely accurate control of either position or speed of a reciprocating member?
5. Apply accurately variable pressure either static or in motion?
6. Closely synchronize various motions, operations or functions?
7. Apply light . . . or heavy . . . forces at extremely high velocities through either long or short distances of travel?
8. Obtain continuous automatic reversing drives at constant R P M or over a wide range of speed variation?
9. Obtain accurate remote control of speed and direction of rotation, rates of acceleration and/or deceleration?
10. Obtain constant horsepower output through all or part of a speed range?
11. Obtain automatic torque control?
12. Obtain accurately matched speed of various rotating elements?
13. Obtain constant speed output from a variable speed input?
14. Obtain full pre-set automatic control, elimination of problems of shock, vibration, etc.?

You Need Oilgear!

OILGEAR

Fluid Power

TAKING THE BUGS OUT OF WORKING DRAWINGS...

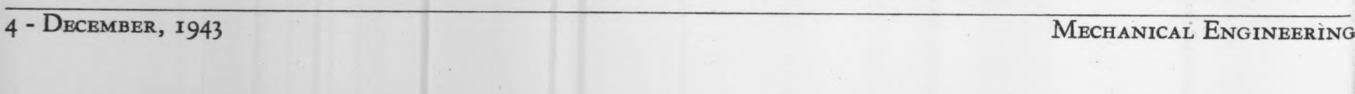
How to make working drawings in a hurry—that are accurate, complete and fool-proof—is the problem.

You can devote your whole time to this problem when you have *Typhonite* Eldorado pencils in your hand. Smooth, accurately graded, strong, they do not throw obstacles in the way. You'll learn why by reading the interesting 23-page booklet describing the Typhonite process.

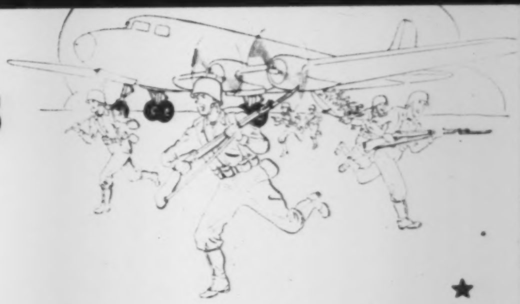
Write for your free copy to: Pencil Sales Department 100-J12 Joseph Dixon Crucible Company, Jersey City 3, N. J.

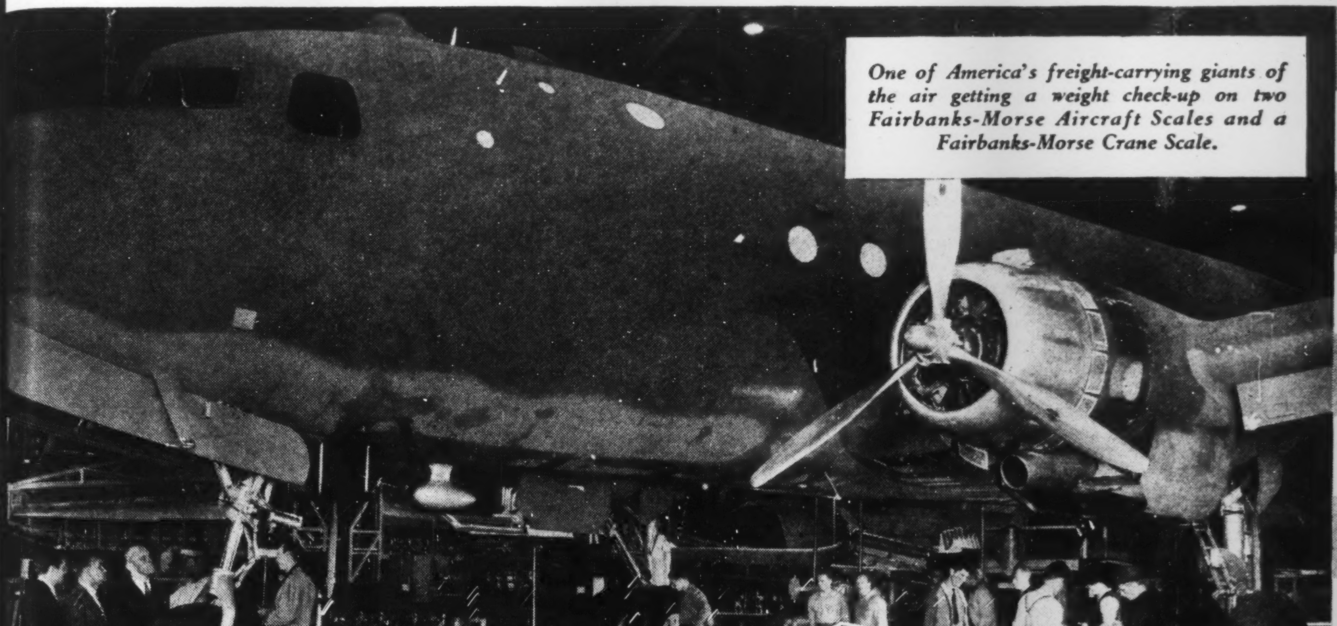
TYPHONITE

ELDORADO



airbanks-Morse Scales in Warwork

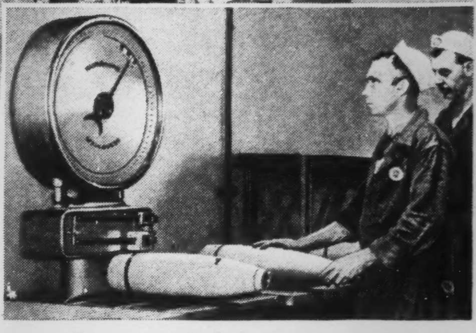




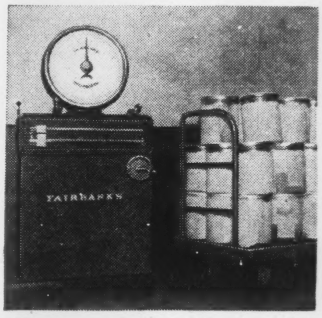
One of America's freight-carrying giants of the air getting a weight check-up on two Fairbanks-Morse Aircraft Scales and a Fairbanks-Morse Crane Scale.

WARWORK means *weigh-work* for Fair-
anks-Morse Scales. They're weighing
unitions . . . food . . . chemicals . . . tanks
. aircraft . . . shells . . . just about every-
ing, in fact. They are weighing at speeds
hich human hands can't match. They're
eighing with accuracy that human eyes
n't equal. They're working in endless
ifts that human stamina can't endure.
ey're helping to speed up America's war
fort on the production front, for Fairbanks-
orse Scales are "at home" on the produc-
on front, in peace or in war. Fairbanks,
orse & Co., Fairbanks-Morse Building,
icago, Illinois.

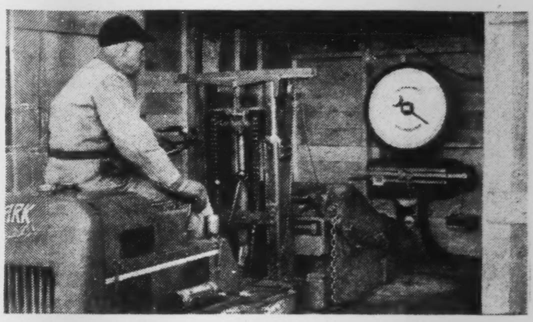
Weighing an "egg" for the Axis.



Correct weight for accurate gunnery.



Frozen eggs—NOT for the Axis!



Weighing charging materials at iron works furnace.

AIRBANKS-MORSE

EL ENGINES
PS
ORS
ERATORS
WATER SYSTEMS
SCALES
STOKERS
FARM EQUIPMENT
RAILROAD EQUIPMENT

FAIRBANKS SCALES

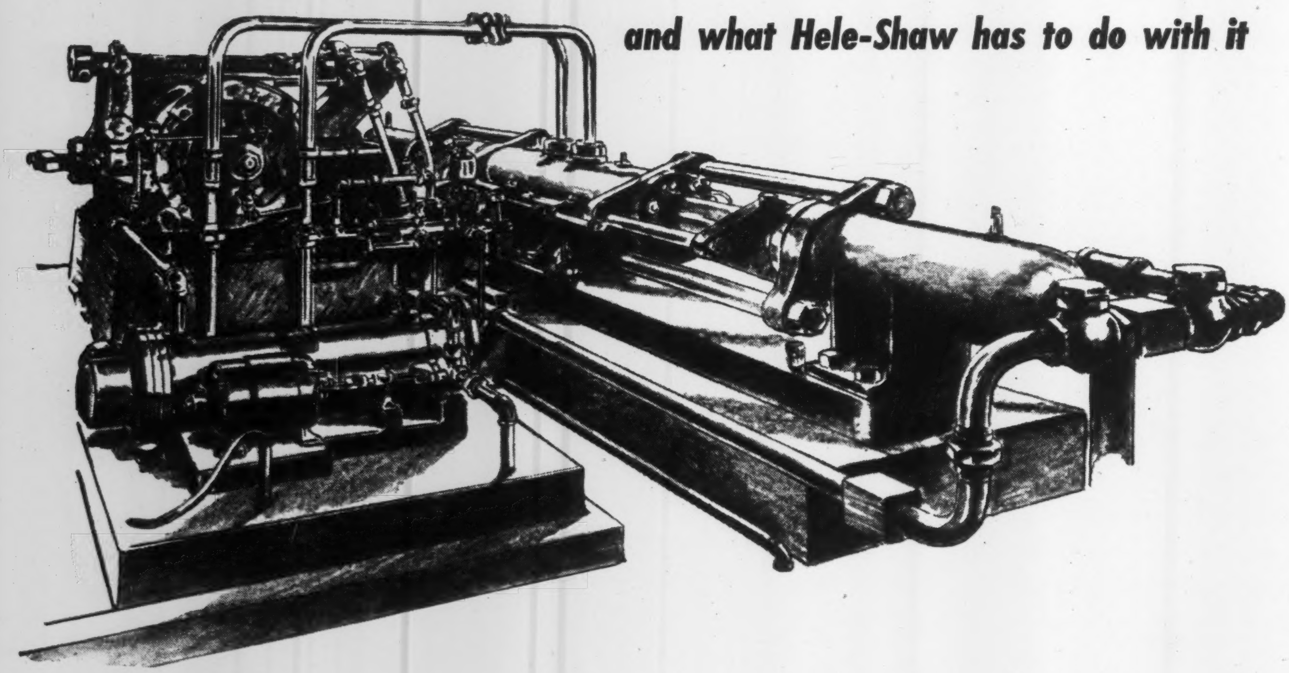
Scales

ARMY NAVY ARMY
F M

BUY WAR BONDS

WHEN IS A PIPE SAFE?—

and what Hele-Shaw has to do with it



Pipes, tubes, and other high-pressure containers used to be tested by complicated arrangements of accumulators, intensifiers and valves. Often, leakage made it impossible to develop proper testing pressures. Sometimes these "one shot" devices failed to hold pressure on the first stroke and a second stroke was necessary.

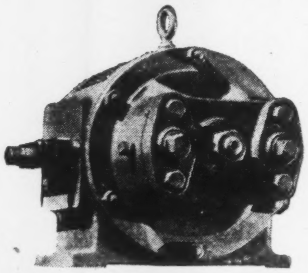
One inventive mind saw a better solution, using Hele-Shaw Fluid Power (oil under pressure). Working with our engineers, he devised a tester for producing high hydrostatic pressures which applied and sustained pressures automatically and free of fluctuations. This improved pipe testing machine could be adjusted quickly over a wide range of pressures, and could be remotely controlled. There were many more advantages.

We're ready to put Hele-Shaw Fluid Power to work for you. Any post-war application concerning the improvement of a product or process, or simplification of control or operation of a machine may be appropriate for the use of Hele-Shaw Fluid Power. Hele-Shaw engineers are ready to help you find out.

THE

Hele-Shaw

Fluid Power Pump



ÆCO 75th ANNIVERSARY

OTHER A-E-CO PRODUCTS: TAYLOR STOKERS, MARINE DECK AUXILIARIES, LO-HED HOISTS

AMERICAN ENGINEERING COMPANY

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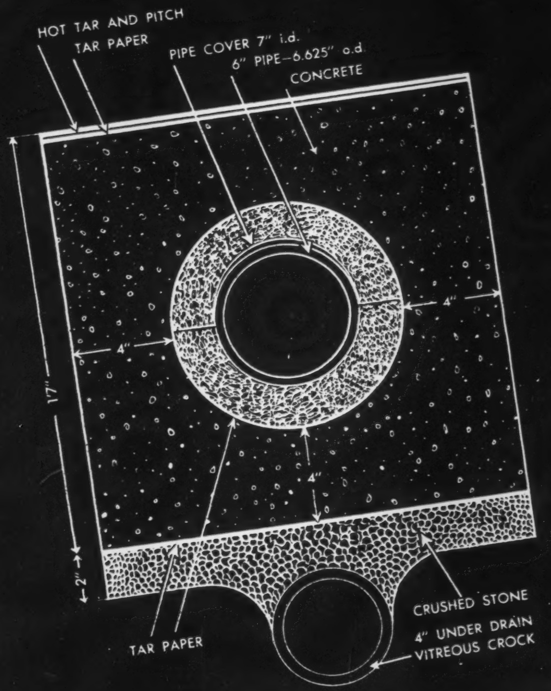
This is the 5TH *in a series of messages*

DEALING WITH THE PROBLEMS IN HEAT INSULATION FACED BY ENGINEERS AND SOLVED BY USING UNARCO unibestos

5a THE PROBLEM: Permanent insulation of underground steam line.

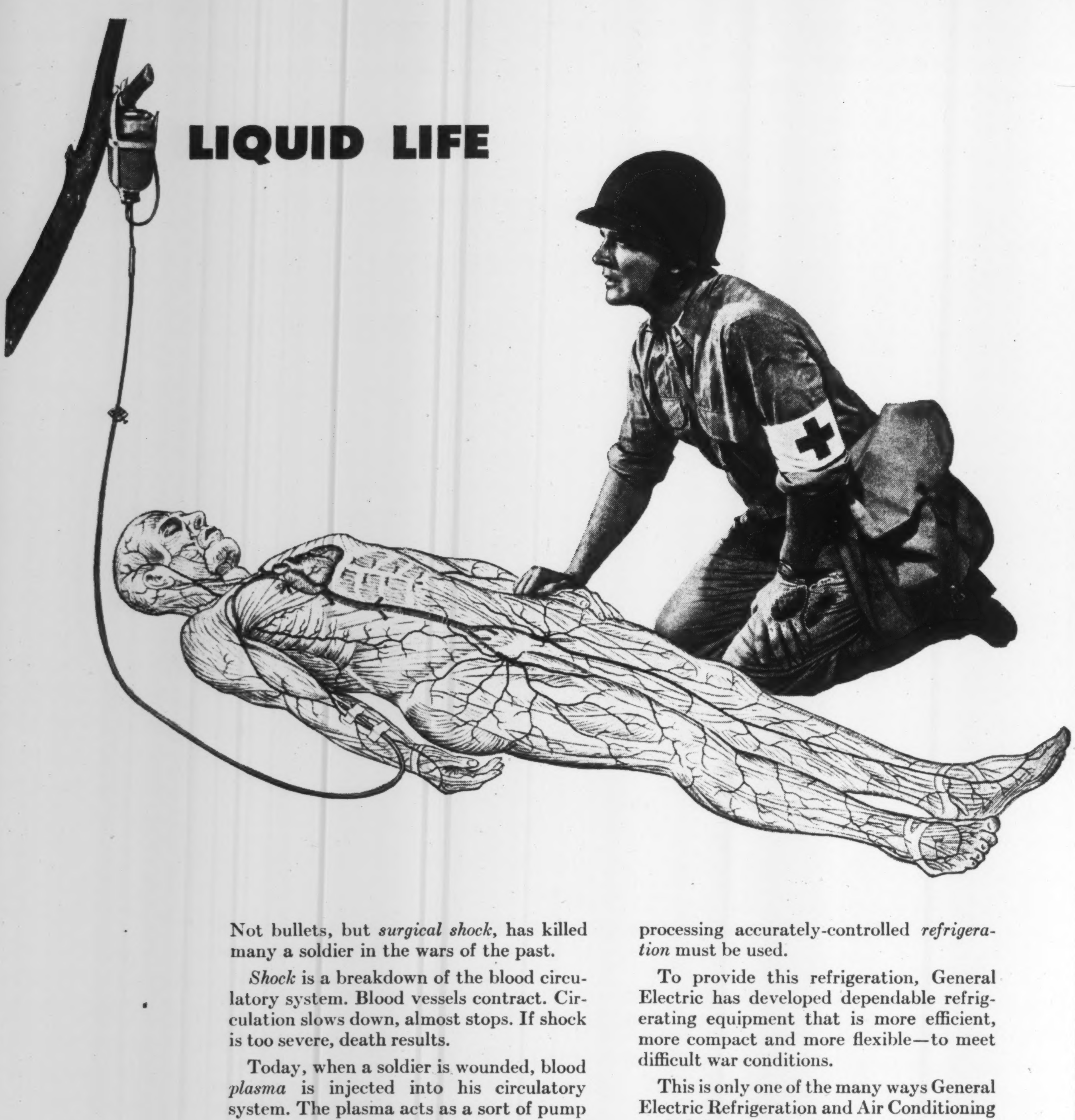
5b THE SOLUTION: Dig underground trench to proper grade and lay sewer tile over which two inches of crushed stone is placed. Cover crushed stone with tar paper. Install pipe on wooden blocks arranged to support pipe for welding. After welding apply Unibestos sectional pipe covering to allow free movement of the pipe within the insulation, insulation should have an I. D. approximately 3/8" greater than the O. D. of the pipe. Pipes should next be brought to proper grade adjustment after waterproofing the insulation. The trench should be filled with concrete. Tar paper and tar can then be applied on top of the concrete to make the structure waterproof. The great structural strength of Unibestos permits this unique installation. Unibestos is sufficiently strong to withstand the movement and weight of the pipe.



UNION ASBESTOS & RUBBER CO.

GENERAL OFFICES: 1821 SOUTH 54TH AVENUE, CICERO, ILLINOIS • NEW YORK • SAN FRANCISCO • PATERSON, N. J.

LIQUID LIFE



Not bullets, but *surgical shock*, has killed many a soldier in the wars of the past.

Shock is a breakdown of the blood circulatory system. Blood vessels contract. Circulation slows down, almost stops. If shock is too severe, death results.

Today, when a soldier is wounded, blood *plasma* is injected into his circulatory system. The plasma acts as a sort of pump primer . . . fills up the collapsed veins and arteries . . . starts the system working again. By thus counteracting shock, plasma saves lives and reduces suffering.

The whole blood you give at a Red Cross blood donor station goes through much processing before it gets to the front as plasma. At many points throughout the processing accurately-controlled *refrigeration* must be used.

To provide this refrigeration, General Electric has developed dependable refrigerating equipment that is more efficient, more compact and more flexible—to meet difficult war conditions.

This is only one of the many ways General Electric Refrigeration and Air Conditioning are helping to make a better world.

☆ **BUY WAR BONDS** ☆

General Electric Company, Air Conditioning and Commercial Refrigeration Divisions, Section 4312, Bloomfield, New Jersey.

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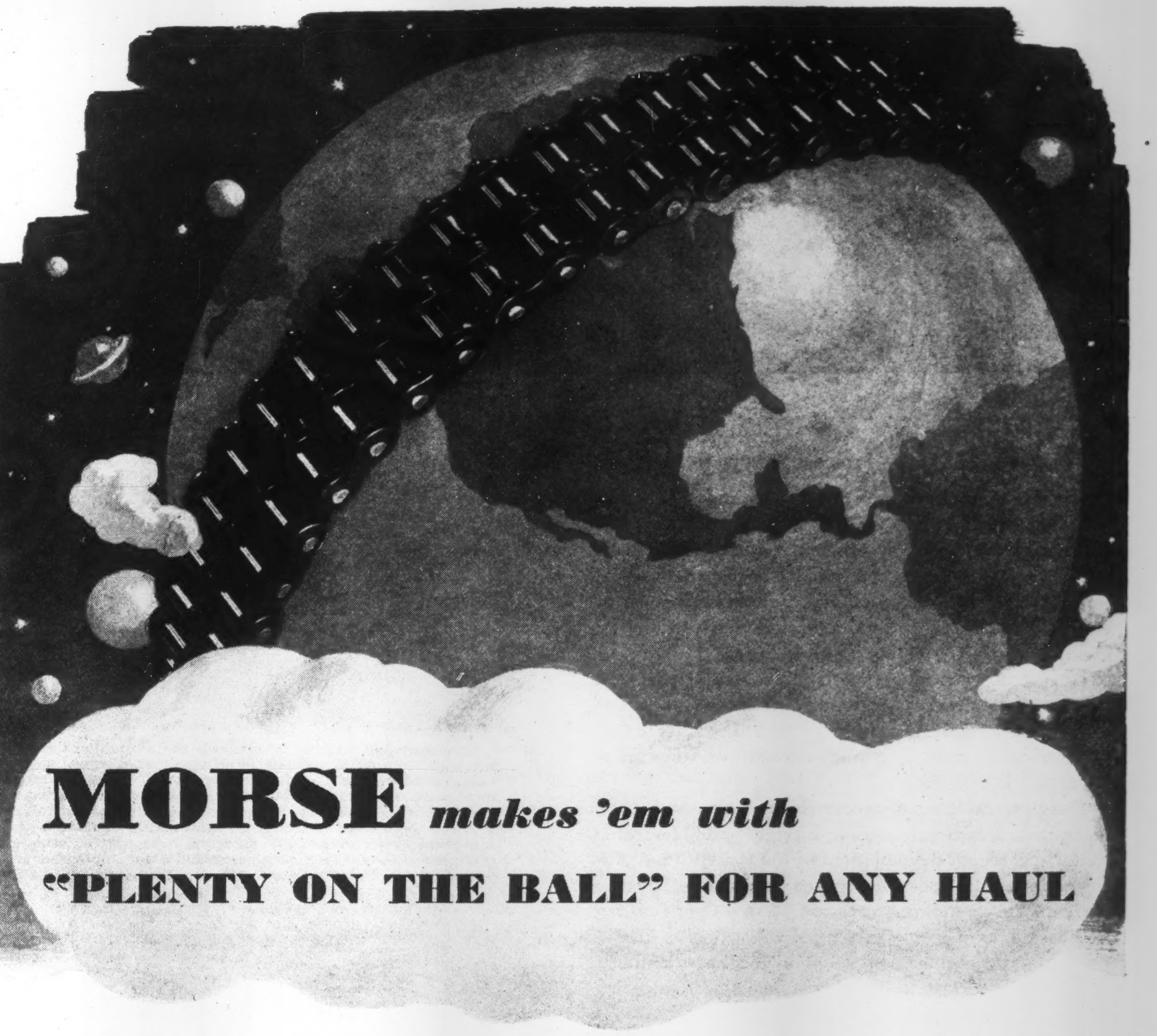
Hear the General Electric Radio Programs: The "HOUR OF CHARM," Sunday 10 P. M., E W T, N B C . . . "THE WORLD TODAY" News, Every Weekday 6:45 P. M., E W T, C B S


MORSE makes 'em with
"PLENTY ON THE BALL" FOR ANY HAUL

MORSE, with more than forty years' experience in the field of power transmission, is an important source of standard and special Roller Chain and Roller Chain attachments.

Today, the phrase "Plenty On The Ball" applies to Morse Roller Chain in more ways than one . . . because today, all around the world, Morse Roller Chain is at work in the automotive and ordnance equipment of our fighting forces. Further, Morse Roller Chain is proving that it has "plenty on the ball" for any haul, for any power transmission job.

If you are a user of roller chain, if you have a design problem concerned with power transmission . . . chances are it will pay you to talk with a Morse man. Naturally, there will be no cost or obligation on your part.

SPROCKETS CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE *Roller and Silent* **CHAINS**

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THESE 7 SOLUTIONS MAY SOLVE 700 OTHER PROBLEMS...

...perhaps your own

"BAKELITE" PLASTICS—Problem Solvers for Industry

When one manufacturer solves a wartime production problem by using the right BAKELITE plastic, the result may be helpful to many other manufacturers. In this spirit, we pass along here the solutions to seven typical problems, any one of which may provide the answer to yours. The plastic materials discussed are, of course, available only for highly essential uses.

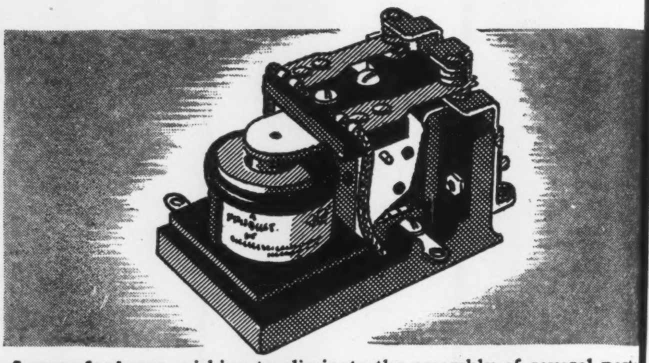
Do you have a tough coatings problem? In recent tests, steel panels coated with a BAKELITE resin primer showed no blistering, pimpling, or rusting after 8,000 hours of continuous water immersion, while other primers failed at 300 hours.

Does the molding of pieces thicker than 3/8 inches, using thermosetting materials, interest you? Heatronic molding, a recent development of the Bakelite Laboratories, makes this possible, speeds curing time 10 to 50 per cent, drops molding pressure 30 to 40 per cent.

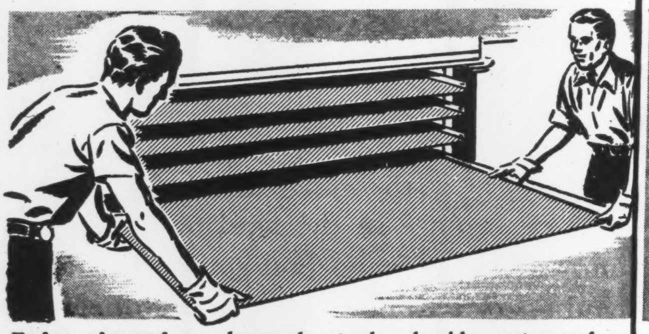
These examples are typical of the scores of developments you will be posted on if you keep in touch with Bakelite Plastics Headquarters. Our Engineering Staff and Development Laboratories have amassed a wealth of data that can help you now with your essential production problems, or with your plans for the days to come.

Write for specific technical literature. Please address Department 13.

BAKELITE CORPORATION
Unit of Union Carbide and Carbon Corporation
UCC
30 EAST 42ND STREET, NEW YORK 17, N.Y.



A manufacturer, wishing to eliminate the assembly of several parts normally required in small relay construction, designed an improved relay for which the base and stationary contact support were to be molded in one piece. A BAKELITE general-purpose molding material was specified for this unusual and complex construction. This material provides the desired dielectric qualities and fine finish. It also withstands the severe vibration encountered in aircraft and shipboard installations, as well as salt atmosphere and wide temperature variations —from 60 deg. F. below zero to 180 deg. F. above.



Today, plywood can be made sturdy, durable, waterproof, an weather-resistant—with BAKELITE phenolic resin glue. Wartime applications, such as the plywood airplane and glider, Army truc bodies, and Navy PT boat sections have demonstrated these properties. Recently, carloads of BAKELITE phenol-bonded plywood were se abroad to make pontoon bridges—stub-nosed boats that will float o rivers for months at a time, withstanding weathering and hard wea

BAKELITE PLASTICS
BAKELITE PLASTICS
BAKELITE
TECHNICAL DATA
BAKELITE
COATING PRODUCTS
MOLDING TECHNIC for BAKELITE and VINYLITE PLASTICS
BAKELITE MOLDING PLASTICS
BAKELITE

Useful Literature on Plastics

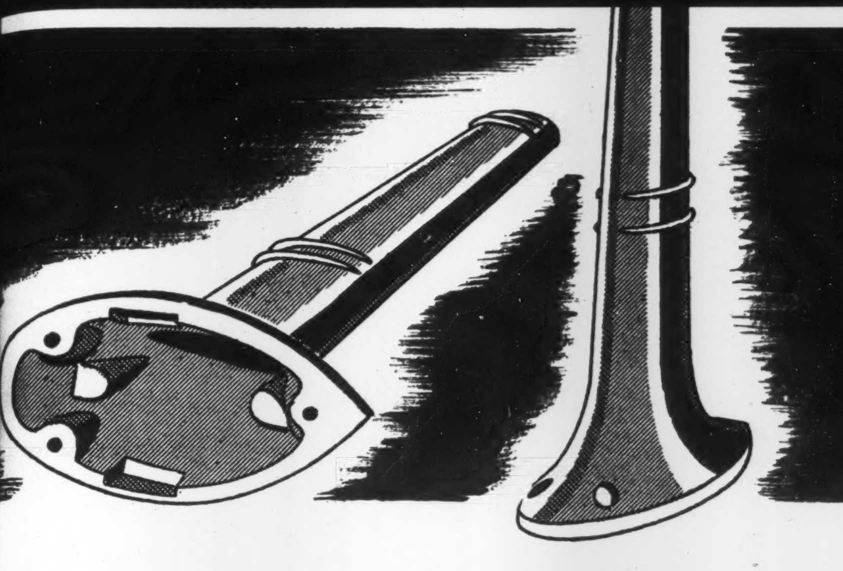
BOOKLET 13-A "BAKELITE HORIZONS" —This pamphlet provides a brief introduction to BAKELITE plastics. Describes the origin of plastics . . . their forms, fabricating techniques, and applications.

BOOKLET 13-P "A SIMPLIFIED GUIDE TO BAKELITE PLASTICS"—A 16-page, illustrated booklet that describes, in digest form, the various types of BAKELITE plastics and synthetic resin products.

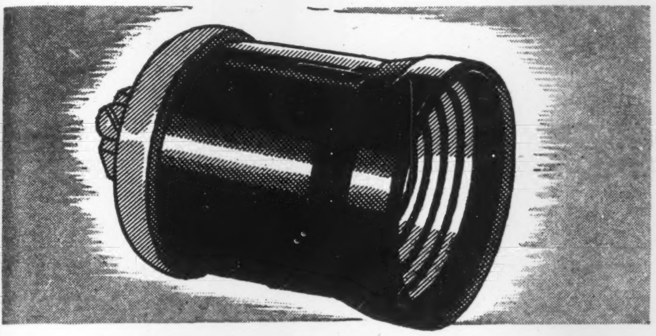
BOOKLET 13-M BAKELITE MOLDING PLASTICS"—A 32-page illustrated reference booklet. Gives technical descriptions of the various BAKELITE thermosetting and thermoplastic molding materials.

"MOLDING TECHNIC FOR BAKELIT AND VINYLITE PLASTICS" (Price $3.5 —A 224-page manual on the art o molding plastics. Contains late technical data the designer, engineer, molder, and user should know about designing and fabricatin hot-set and cold-set molding materials.

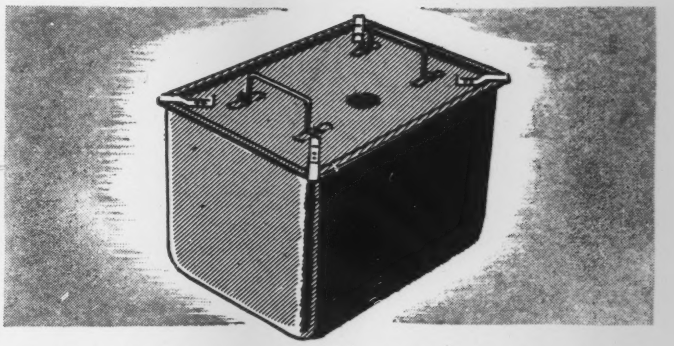
BOOKLET 13-L "BAKELITE LAMINATIN PLASTICS"—A 24-page illustrate booklet. Describes, in detail, vario



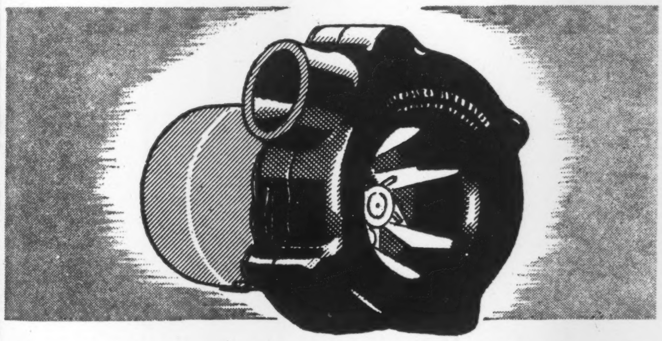
AN INTERESTING FEATURE of the huge Curtiss Commando troop transport plane is its use of an extremely lightweight, yet tough and durable antenna and pitot tube, molded at low pressure using a BAKELITE laminating resin. To provide strength needed to withstand air pressures encountered in flight, the mast is molded in one piece, using a special "creped" cloth. Unlike conventional laminating cloth, this material, after it is impregnated with BAKELITE phenolic resin, is "creped" so that it can stretch in all directions in the molding process. Since the laminations remain intact, the finished mast has unusually high mechanical strength.



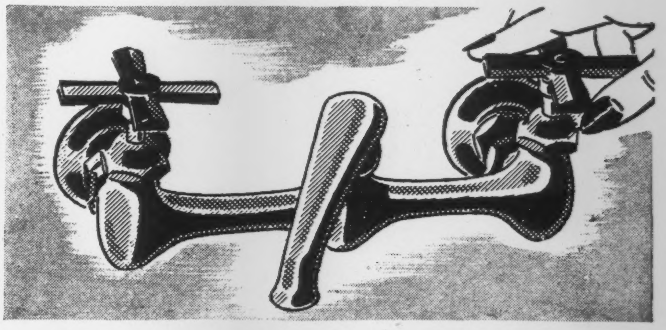
Now, lighting fixture sockets aboard America's Victory Ships are molded of BAKELITE phenolic plastics. They are lighter, more compact, and more durable than sockets previously used. The manufacturer found that less breakage and faster assembly made possible a production jump of 10 to 15 per cent . . . pushed costs down 10 per cent. The new socket has been approved for use aboard all ships of our Merchant Marine, where it will withstand vibration and extremes in temperature change.



The lining of the food containers used in Medical Corps hospital food carts must stand up against constant scraping with ladle or spoon when serving, and sudden temperature changes on sterilizing. That's a tough assignment for any coating. Yet a BAKELITE resin baking finish does the job—and does it well. Known best before the war for its use in insulating and bonding armature and coil windings, these glasslike coatings have passed many rigid requirements in meeting today's wartime needs in replacing plated linings for cans, drums, and tanks.



A tiny blower measuring only four inches in diameter, weighing only four ounces, cools the radio and other electronic equipment on America's fighting aircraft. Using a BAKELITE general-purpose phenolic molding material, the manufacturer has been able to mold the lightweight blower housing to close tolerances, yet secure good heat resistance and mechanical strength.



Army, Navy, Federal housing developments, and Navy and Maritime ships are using plumbing accessories molded of BAKELITE cellulose acetate. Five hundred thousand faucet handles have already been produced—and are proving highly successful because of their low heat transmission, good heat resistance, fine appearance, and resistance to corrosion. Other developments include a shiny white elbow, for toilet flush tanks that will not shrink or distort in service.

ypes of laminated plastics made vith BAKELITE laminating varnishes, and illustrates many appli- ations. Outlines fabricating techniques, and gives ASTM data.

OOKLET 13-V "BAKELITE HEAT-HARD- ENABLE VARNISH, ENAMEL, LACQUER, EMENT" — A 40-page illustrated ooklet. Describes resin-baking oatings and bonding materials— heir properties, uses, and advan- ages.

OOKLET 13-F "BAKELITE C-9 RESINS" —A 12-page illustrated booklet for he paint and varnish technologist. Shows how these new resins accelerate bodying time and improve performance of many surface coatings.

BOOKLET 13-J "BAKELITE COATING PRODUCTS" — A 4-page folder for the paint and varnish technologist, describing the new water emulsions based on C-9 resins.

BOOKLET 13-Q "BAKELITE SEALING SOLUTIONS FOR POROUS CASTINGS" —A 4-page folder that tells how to reclaim porous and spongy castings by impregnating with resin-baking solutions.

BAKELITE

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For over 30 years . . . engineers, designers, draftsmen, and maintenance supervisors have specified and used Barco Flexible Joints in important services. They have incorporated Barco Flexible Joints in designs and services where flexible connections have been required to take care of movement or absorb vibration in the transmission of steam, air, oil, water, chemicals, and many other fluids and gases. Because of their ability to stand high pressures, high temperatures, and rough handling they have proved to be the most economical and satisfactory flexible conveyor obtainable. Our engineering department will give you the information necessary to work out your flexible joint problems. Write to: Barco Manufacturing Company, 1807 Winnemac, Chicago 40, Illinois.

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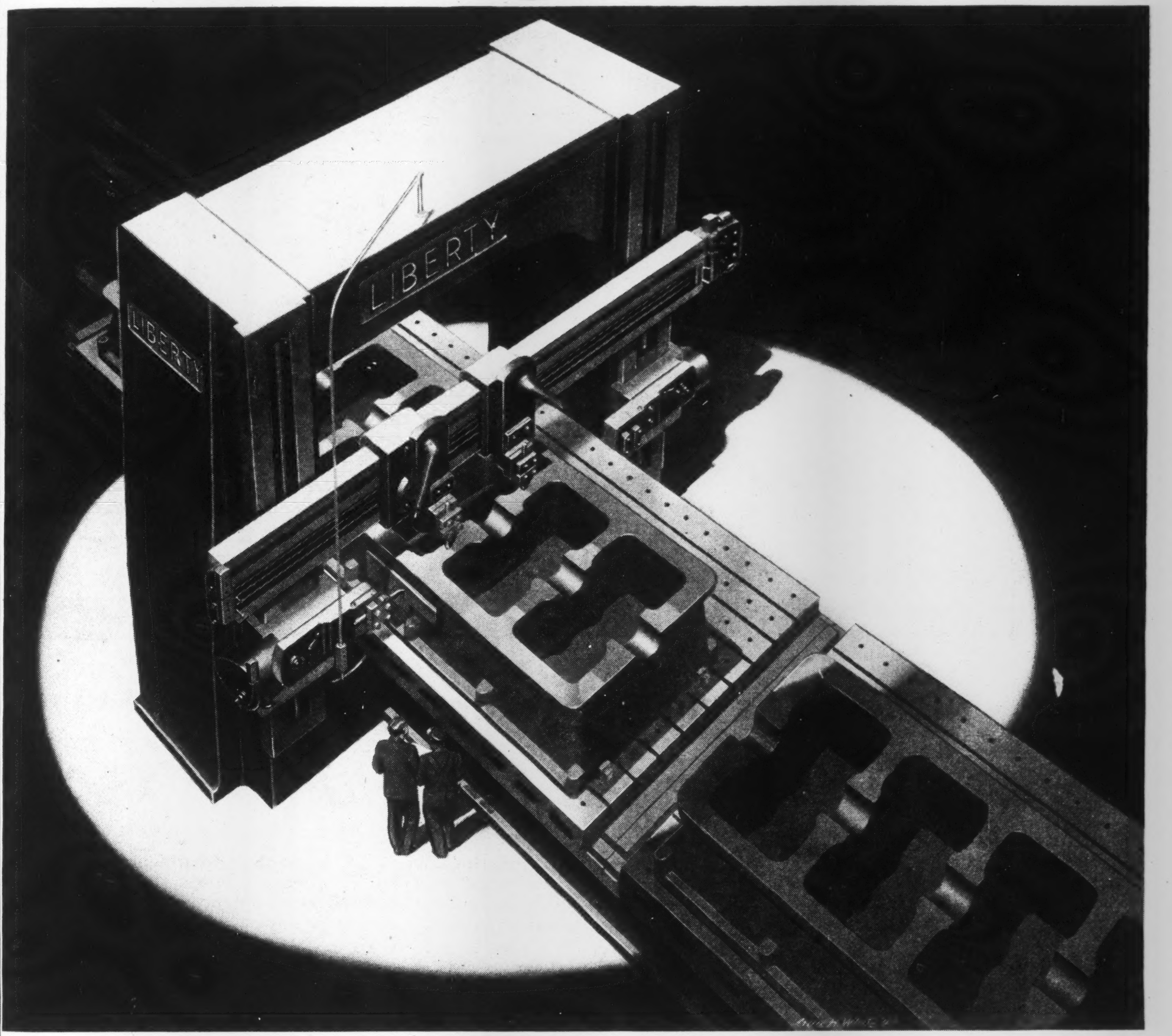

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FOR *FAST,* ACCURATE, BIG SCALE PRODUCTION

A limited number of these Heavy-Duty Liberty Planers *now ready for delivery.* Wire, telephone or write for full particulars.

Also ask for Cat. No. 152, which illustrates and describes many other LIBERTY Planer styles and sizes that are now available.

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Over a Quarter Century of Specialized Experience with Time-Tested Principles of Design

NICKEL AIDS THE CONSTRUCTION INDUSTRY

to KEEP 'EM WORKING!

Engineers who design construction equipment can take pride in the construction industry's greatest achievement...its part in building America's "Arsenal of Democracy."

For they contributed to that amazing success, even long before the war started. They designed the tools with which the job was done...found ways to make equipment durable, and thus prevented many a breakdown of machinery at this critical time when nothing must interfere with the drive toward Victory.

Familiar to them, as a means of giving longer life to construction equipment, is the widespread use of Nickel Alloys. Those engineers have learned from long experience that Nickel imparts toughness, strength, and corrosion resistance to ferrous and non-ferrous metals, and thus assures improved performance under the most severe conditions.

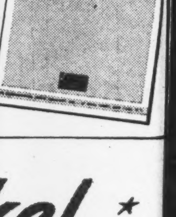
Among them, as with men in many other industries, the saying is that "a little Nickel goes a long way" toward increasing dependability of machine parts—from gears to scraper blades, from dipper teeth to crusher rolls.

The experience of contractors, engineers, and machine operators in the field supports this conviction of the designing engineers...proves that the products of leading manufacturers stand up longer under the stress of exacting service.

It has been the privilege of INCO engineers and metallurgists to cooperate with the construction industry for many years. To men in all industries who desire assistance in the selection, abrication, and heat treatment of ferrous and non-ferrous alloys, the International Nickel Company cordially extends an offer of counsel and data.

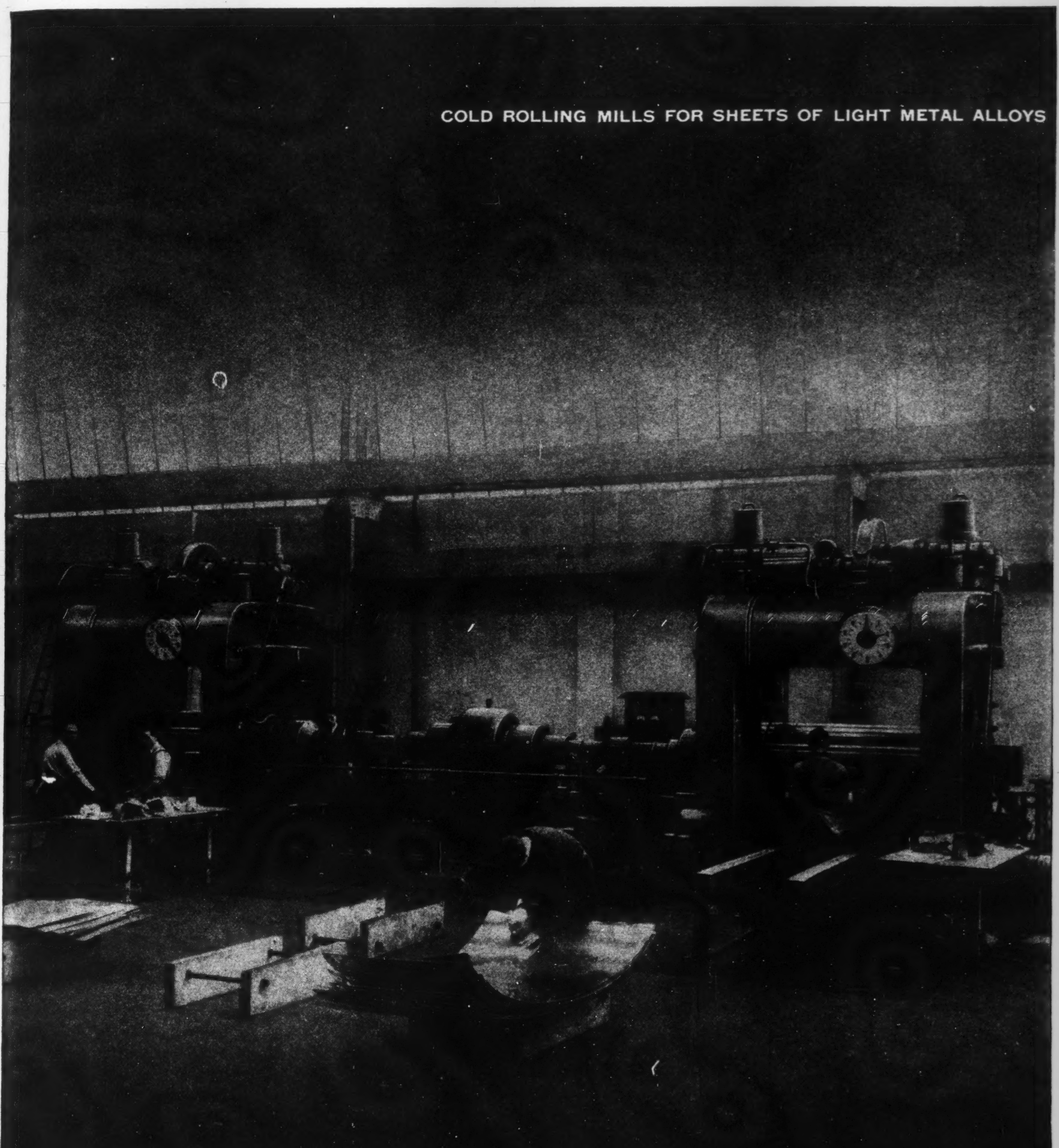
New Catalog Index

New Catalog C makes it easy for you to get Nickel literature. It gives you capsule synopses of booklets and bulletins on a wide variety of subjects—from industrial applications to metallurgical data and working instructions. Why not send for your copy of Catalog C today?



* Nickel *

THE INTERNATIONAL NICKEL COMPANY, INC., *67 Wall St., New York 5, N. Y*



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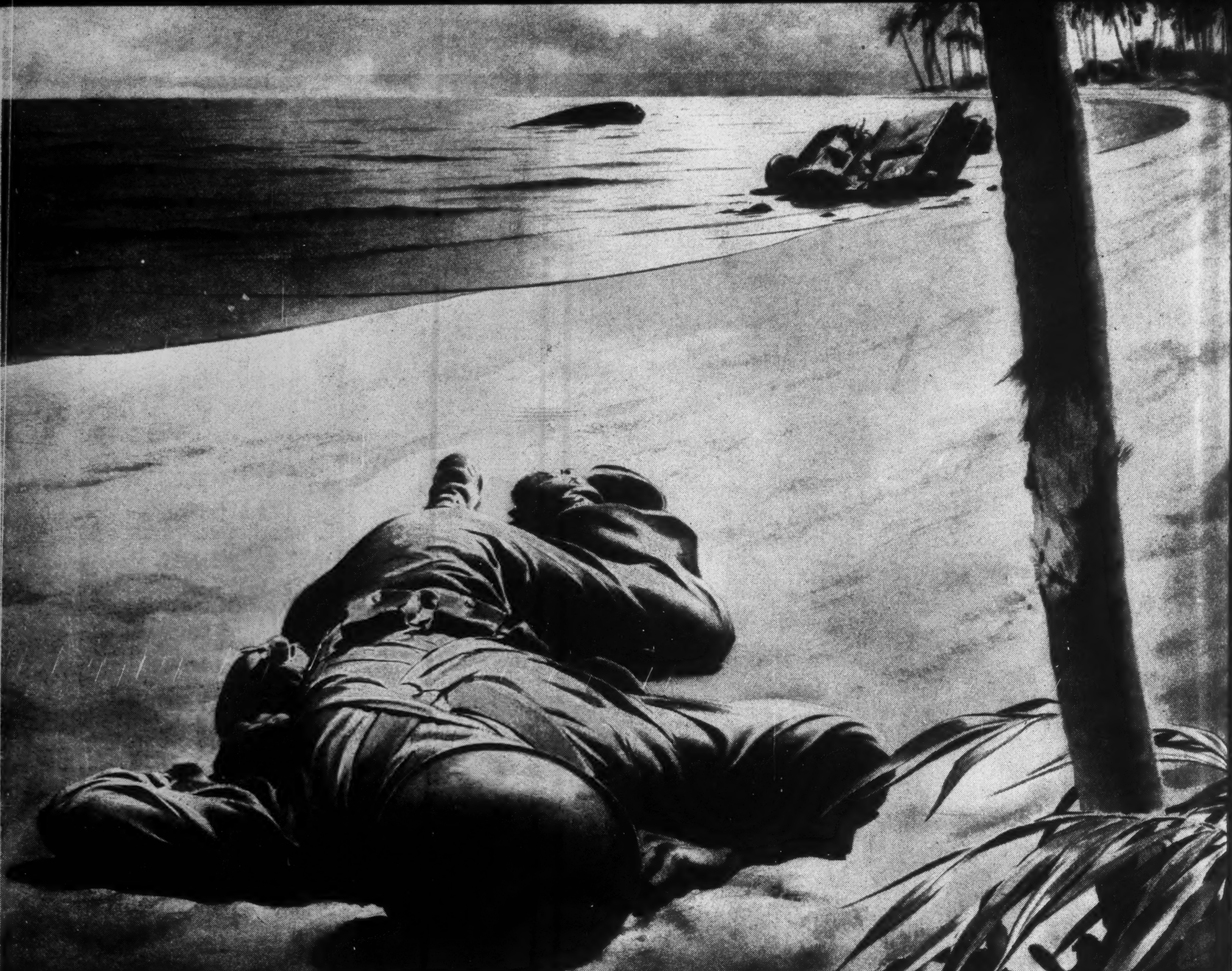


(Painted from an actual war photograp

A MESSAGE TO THOSE WHO FORGET

We have a photograph very much like the illustration on this page, but we cannot publish it.

Its grim reality is simply too shocking; and yet that very reality might serve a useful purpose. For, all too many of us read the casualty list in terms of numbers, forgetting that each unit in the number is an American boy lost or wounded or dead.

In very much the same way we read figures about production at home, forgetting that figures on production—and figures on lowered production due to slow downs—can be a real measure of the men who won't come back.

It is only when we think of these numbers of lost hours of production in life-and-death terms of men, that we realize how vital it is to win the *earliest* victory; and that the way we at home can best contribute toward this, is to eliminate industrial slow downs.

Fortunately many types of slow downs *can* be prevented.

Not among the least of these is the slow down due to valve failures. The way to prevent this type is *to avoid valve trouble before it starts.*

Have the valves in your plant inspected *regularly.* Have the operation and maintenance of valves entrusted to experienced hands. If workers *are* new, be sure that they are trained at the earliest moment to operate valves properly. When new valves are installed, make sure that they are selected and installed by experts.

Jenkins Engineers are ready to assist any management in developing a practical program of valve conservation.

Reprints of this advertisement are available for display in your plant.

Jenkins Bros., 80 White Street, New York 13, N. Y.; Bridgeport, Conn.; Atlanta, Ga.; Boston, Mass.; Philadelphia, Pa.; Chicago, Ill. Jenkins Bros., Ltd., Montreal; London, Eng.

REG. U.S. PAT. OFF. TRADE JENKINS MARK

JENKINS VALVES

SINCE 1864

For every industrial, engineering, marine and power plant service . . . in Bronze, Iron, Cast Steel and Corrosion-Resisting Alloys . . . 125 to 600 lbs. pressure.

• Keep Informed . . .

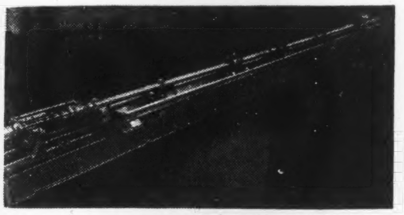
Announcements in this section are supplied by current advertisers in MECHANICAL ENGINEERING and A.S.M.E. MECHANICAL CATALOG. This section is restricted to these advertisers.

- ***NEW EQUIPMENT***
- ***BUSINESS CHANGES***
- ***LATEST CATALOGS***

Available literature may be secured by addressing a request to the Advertising Department of MECHANICAL ENGINEERING or by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• *NEW EQUIPMENT*

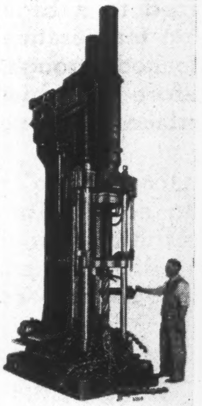
The Largest Internal Honing Machine in the World



The above illustration shows the largest, hydraulically operated, Honing Machine built exclusively by Barnes Drill Co., Rockford, Illinois. The machine, having a 76-foot spindle stroke, is capable of honing 42 inch diameter. Has automatic spindle rotation and hydraulic reciprocations. The Micromatic honing tools are also hydraulically expanded to a positive stop for final size. Short stroking at any point and withdrawal of hone from the work piece are under control of the operator. Over-all length of machine, including work support bed, is 184 feet—2 inches. Total weight of the machine is 91,130 pounds.

Total weight of intermediate driver and honing tool is 7,500 pounds. Bulletin No. 135-D describes features, advantages, and specifications of various "Barnesdril" Horizontal, self-Oiling Hydraulic Honing Machines for Internal and External Honing.

Inverted Process Drilling



The illustration shows one of the Heavy Duty Hydraulic Feed Drilling Machines made by Barnes Drill Co., Rockford, Illinois. It is original in design and typifies their line of "Hydram" Drilling, Boring and Reaming Machines. The sturdy, flared and flanged column on each size machine, supporting the spacious superstructure, presents a well proportioned mass of tremendous strength, rigidness and power. The hydraulic cylinder carrying the ram (hence "Hydram") and the spindle are placed so as to bring the feeding pressure directly above the work.

Briefly the work is chucked on the spindle and the twist drill is held stationary on the base with oil tubes running through the twist Drill, feeding coolant under 250 lbs. pressure to the point of the twist drill. Thus gravity and the flow of oil constantly clear the chips. On a job some 28″ with a 4 5/32″ twist drill, the time has been cut from 6 hours to 25 minutes.

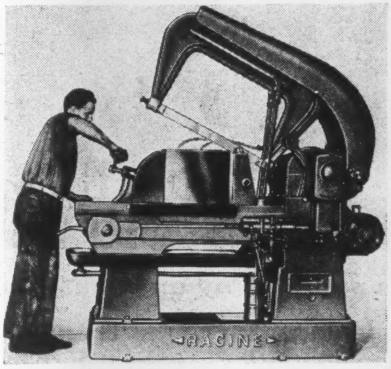
Bulletin No. 134-E illustrates and describes the features, advantages and specifications of the "Barnesdril" Hydram, Self-Oiling, Hydraulic, Drilling, Boring and Reaming Machines. A repeat of a recent article on "Inverted Process Drilling" also is available.

Multi-Pass Electric Oil Heaters

The Hynes Electric Heating Co. have extended their line of Multi-pass electric oil heaters. This includes many new sizes, explosion-proof units, and special high velocity flow types. These electric heaters are used for preheating fuel, lubricating and insulating oils for centrifuging, and for heat transfer oils to be circulated through jacketed process vessels. They are also used in heating chemicals and other liquids under pump circulation. The controlled flow of compact yet large area surfaces of low unit heat density insures an exceptionally efficient heat transfer without local hot spots.

Full details about the Hynes Electric Heating systems for circulating oils and other fluids can be obtained by writing to the Hynes Electric Heating Co., West & Clinton Sts., Camden, N. J.

New Heavy Duty Hydraulic Metal Cutting Machine



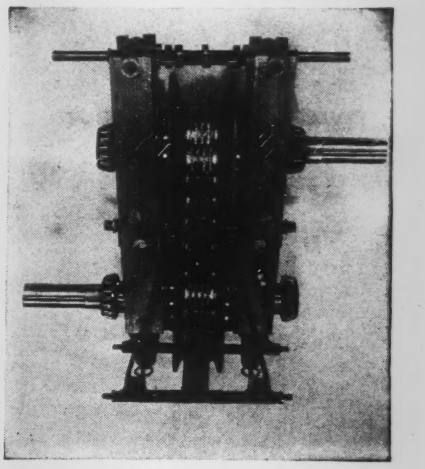
The Racine Tool & Machine Co., Racine, Wis., has just announced the development of a new 20″ × 20″ capacity Metal Cutting Machine known as their model #36C illustrated above. It is said this machine was designed primarily to provide low cost cutting with a thin cutting tool in large size materials. It is claimed that this machine is particularly adaptable to use on die block steel and other costly materials. The comparatively light-weight blade used removes only a small amount of metal in the form of chips, and where multiple cuts are made it is claimed a substantial saving results from this feature alone.

This machine is hydraulically operated, full control being placed on a single lever. A special dual type feed is used which the manufacturer claims is an exclusive feature possessing rather novel advantages. It provides a fast-cutting speed in light materials and yet is arranged for a positive predetermined rate of cutting in die blocks, alloys and tool steel. A three speed transmission provides cutting speeds of 55–85 and 115 strokes per minute. A three H.P. motor drive through "V" belts is connected to the three speed transmission by a Twin Disc clutch.

The manufacturer offers a new bulletin entitled "Presenting No. 36-C" in which complete information is given on this new machine.

Infinitely Variable Speed P.I.V. Gear Mechanism Now Available for Integral Designing into Machine Tools

The proper cutting speed of a machine tool is determined by many factors, such as the cutting tool material and heat treatment, tool life, the material to be machined, the coolant used, type of cut, and size of chip. Some of these values are known, whereas others must be determined in practice.



And it follows that the operator is free to regulate the cutting speed to suit the tool, work, and other variables when the machine is equipped with infinitely variable speed that is instantly available without shutting down the operation.

In attempting to modernize existing machine tools to meet present-day conditions and achieve the maximum in production, many machine tool *users* have purchased and mounted or in some way applied complete self-contained P.I.V. variable speed transmission units to these machines. Certain machine tool *builders* have also applied complete commercial P.I.V. variable speed units to existing designs.

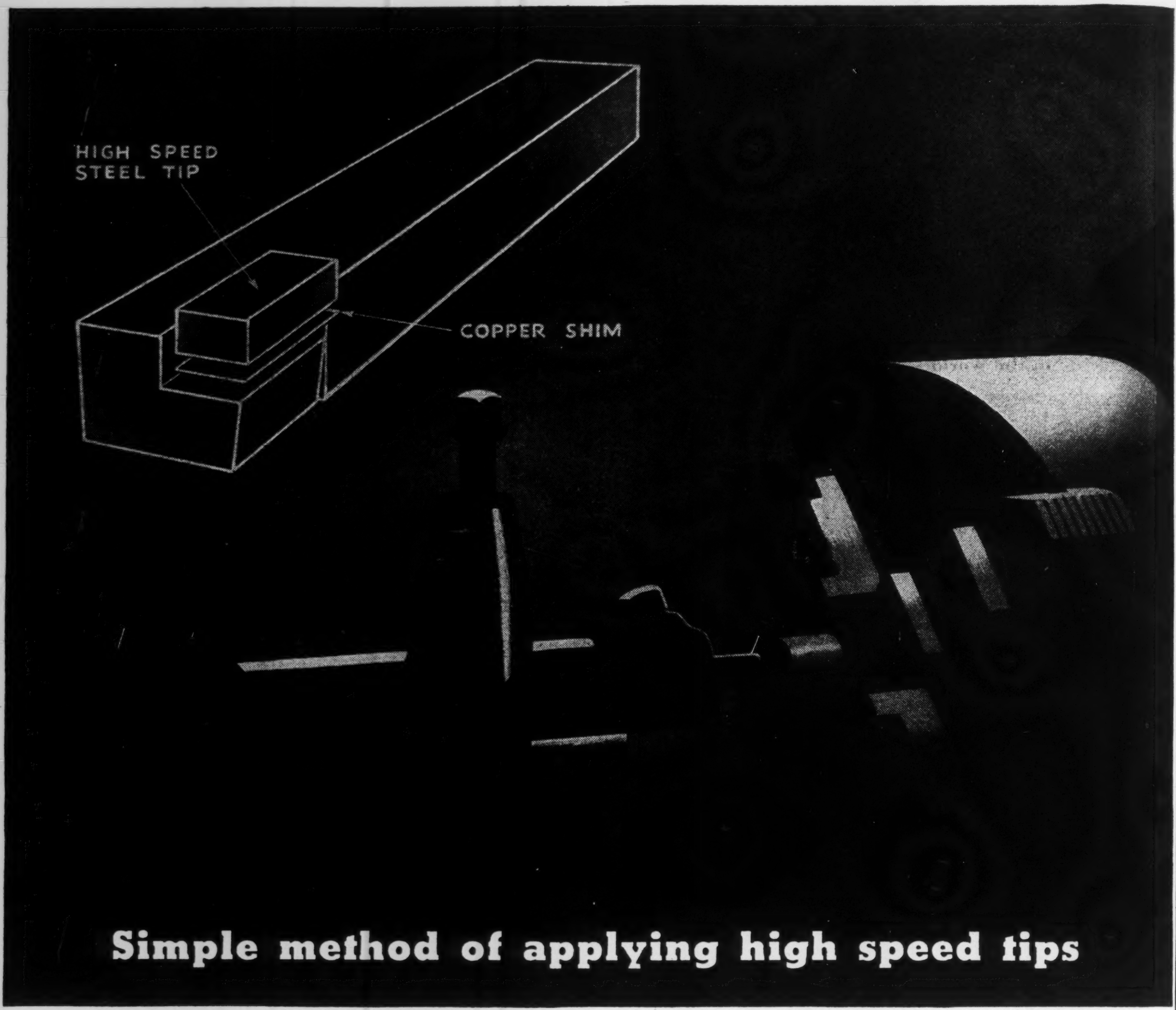
Now however comes an announcement by Link-Belt Co., Philadelphia, 40, that they are prepared to supply the bare mechanism of their P.I.V. Gear (without housing) together with technical information which will enable the machine tool engineer to embody this infinitely variable speed transmission into the machine as an integral part of it, even running it in the same oil reservoir with the change gear sets.

The bare P.I.V. mechanism is shown in photograph. The operating speed within each speed range is regulated by handwheel or lever.

As always, the P.I.V. Gear mechanism is of compact, all-metal construction, employing a unique positive drive chain making side contact with radial teeth cut on the two adjustable-diameter discs constituting each of the two wheels the chain connects.

P.I.V. Gear catalog No. 1874 and further information on the application of the bare

Continued on page 23



Simple method of applying high speed tips

Information supplied by an Industrial Publication

Copper brazing offers a readily available means of mounting high speed steel tips on low alloy shanks for cutting tools.

The procedure is quite simple. A recess milled in the shank is thoroughly cleaned and coated with brazing flux. The flux is also applied to the high speed steel tip. A copper shim (0.003 to 0.005 in. thick) is cut to the size of the recess.

The shank is heated until the flux flows freely before the shim is fitted in the recess. After the shim and tip are put in place, the assembly is brought up to 1650° F., in a preheating furnace.

Then the assembly is transferred to a high heat furnace and held at quenching temperature (2200-2350° F.) until the tip is soaked through. Copper melts at 1980° F., therefore the shim will melt and spread over the interfaces, forming a firm bond.

After withdrawal from the furnace the tip is aligned and pressed into place to squeeze out excess copper and flux. As soon as the tip is well bonded to the shank, that end is oil quenched. Final operation consists of the usual high speed steel temper at 1000-1050° F.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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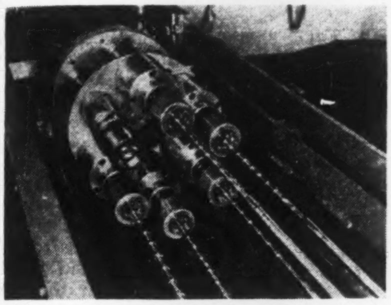
Climax Molybdenum Company
500 Fifth Avenue • New York City

• Keep Informed

P.I.V. mechanism to integral machine tool designs, or complete in housings of standard or special design, may be obtained by writing direct to the Link-Belt Plant at 2045 W. Hunting Park Avenue, Philadelphia 40, Penna.

Broaching Information Available



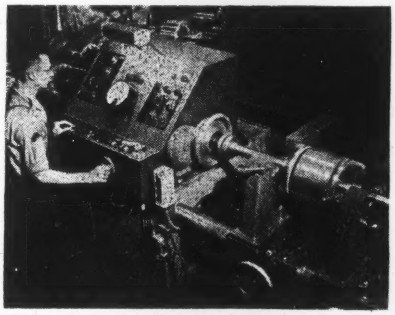
Pictured above is the 5-broach indexing head for the new Lapointe Broach Rifling Machine which does all internal rifling jobs on guns ranging from the small Reisings and Garands to the large Bofors and 125 mm. Anti-aircrafts. Information on this new broaching operation along with information on airplane manufacture by broaching is now available from the parent company.

While broaching is a relatively new type of machine to most industrial shops, it was largely responsible for the large automobile and appliance production of precision parts and now is used in all types of armament manufacture where precision and production is required.

The Lapointe Machine Tool Co., Hudson, Mass., pioneers in the art of Broaching—Bulletin numbers on Standard Machines as follows: Horizontal Machines, #126–132; Pull Down, #125; Single Ram Surface, #130; Duplex Surface, #131; Vertical Presses, #110 & #111; Broach Sharpener, #120; Hydraulic Pumps, #122 & #127; Universal Horizontal, #129; Rotor Kut Broaches, #100; also standard broach charts. A card or letterhead will put you on the mailing list for future bulletins.

Precision Balancing

Unbalance of armatures can be located in $^1/_8$ to $^1/_{10}$ the time required for mechanical balancing with this dynetric balancing unit used by Westinghouse at East Pittsburgh. It is possible to precision balance armatures for 50 HP to 200 HP motors to $^1/_{10,000}$ of an inch of linear movement. Last month, 1000 armatures were balanced on this machine.



The operator proceeds as follows when he balances an armature: (1) Places the shaft of the armature in floating bearings. (2) Connects the armature shaft to that of a motor driven sine wave generator. (3) Adds a known weight of molding clay to one end

Continued on page 24

Everything Under Control

• • • OF THE "BIG VOICE"

Commands and instructions over loud speakers direct the operations of landing forces and combat units. To operate these, and other communication systems, power is supplied by portable gasoline engine powered generators. One more combat duty added to the many standard and special applications powered by hundreds of thousands of dependable, instant-starting, 4-cycle, air-cooled Briggs & Stratton engines now serving our armed forces.

INQUIRIES are requested from those manufacturers who require portable gasoline engine power for war production — or for their post-war gasoline-powered equipment now being planned.

We are better prepared than ever to carry on the traditions of Briggs & Stratton engines — with the same high standards of quality and precision manufacture, their rugged dependability, easy starting and economical performance — all the features that have earned for Briggs & Stratton the reputation of "the world's finest air-cooled gasoline engines."

"It's powered right — when it's powered by Briggs & Stratton"

BRIGGS & STRATTON CORP.
MILWAUKEE 1, WIS., U. S. A.

BACK THE ATTACK
BUY WAR BONDS

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

FRASER-BRACE ENGINEERING CO., Inc.

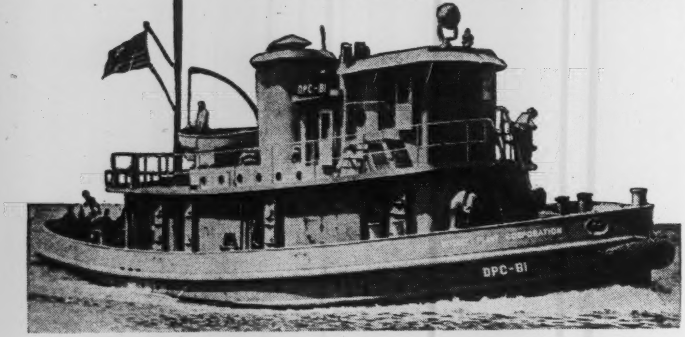
Design, construction and installation of complete plants and projects

Mechanical, Heavy Industries, Shipbuilding, Hydro-Electric Developments, Power Plants, Chemical and Refining Plants, Process Industries, Metallurgical Developments and Processes, Explosives, Plastics, Water Supply and Treatment, Sewage and Industrial Wastes Treatment.

• REPORTS • APPRAISALS • CONSULTING •

10 East 40th Street New York 16, N. Y.

IF YOU WANTED A LOT OF PUMPS FOR SPECIFIC JOBS... IN A HURRY ... WHERE WOULD YOU GO?



Write, stating the type of work you are engaged in, and Goulds will forward you a complete set of literature illustrating and describing the Goulds Pumps that have been developed specifically for your industry. Goulds Pumps are available, if you have a suitable priority rating.

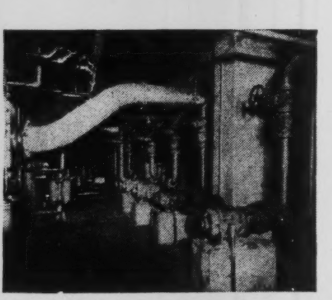
SUPPOSE you were handed the orders for a whole fleet of coastwise tugs, each of which had to be equipped with half a dozen pumps . . . and each pump *had* to be designed for the job it was to do?

Suppose you had the contract for an oil pipe line with a dozen or more heavy duty, high pressure pumps able to stand up under continuous 24 hours a day service?

Or suppose you were completely re-equipping your plant to meet increased production demands and your whole process hinged on the fluid handling efficiency of your pumping system?

Where could you go where you would be sure of getting *the* pumps that were designed to do those specific jobs? Where could you go where you could get any or all of these pumps from the *one source?*

Goulds has the answer to that . . . as it had in the actual cases mentioned here. Out of 96 years of exclusive specialization on pumps and pumping problems Goulds has developed a complete line of pumps designed to meet any pumping requirements, large or small. Because no one pump, nor any one type of pumping equipment, is suitable for all purposes, Goulds, as pump specialists, offer a complete line of reciprocating, rotary and centrifugal pumps in all sizes and capacities, out of which can be selected *the* pump for *the* job.

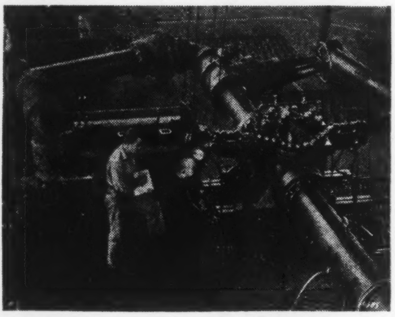


Goulds
PUMPS INC.
SENECA FALLS, N. Y.

of the armature at the 0 reference point of the sine wave generator index wheel. (4) Rotates armature at 600 rpm. (5) Manually adjusts sine wave generator until the rotor is in phase with the stator, at which point the armature is in balance with the machine. (6) Weight of metal necessary to bring one end of the armature in balance is read on the scale of the large instrument in center of panel. The horizontal movement of the armature, due to vibration, is transmitted by the floating bearings through a mechanical connection to an electrical coil whence it is electrically transmitted to electronic tubes which amplify the unbalance so it can be recorded by the instrument. (7) Sine wave stator index wheel indicates place on armature with respect to 0 reference point of the sine wave generator index wheel where the weight that was read on the instrument must be added to bring that end of the armature in balance. The operator then repeats these steps for balancing the opposite end of the armature.

Ingersoll-Rand Pumps on 20″ War Emergency Products Line

Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y., is supplying 41 pumps for the War Emergency Pipe-Line project known as the 20″ Products Line. This line will parallel the 24″ line, popularly known as the "Big Inch." The Products Line will carry finished refinery products, such as gasoline and fuel oil, whereas the "Big Inch" will normally carry crude oil.



The pumps, which were especially designed for this particular job, are single-stage, centrifugal units. Since it was specified that no critical materials should be embodied in the pumps, all major castings are of high-grade cast iron.

Each pump is driven by a 3570-rpm, 1500-hp electric motor and operates against a total head of 825 ft. Three such machines in each pumping station will operate in series to produce a final line pressure of 800 lb. per sq. in. This pressure is gradually reduced by friction between stations until the suction pressure at the succeeding station is about 30 lb. per sq. in. The first pump in the series of three builds this pressure up to 287 lb. per sq. in.; the second one to 544 lb. per sq. in.; and the third one to the final pressure of 800 lb. per sq. in. Capacity of the line will be 235,000 barrels per day, which is 6855 gpm.

The pumps are so designed that two may operate in series or one may operate alone if such an arrangement is desired. With two pumps operating in series, the line will deliver about 83% of its rated capacity, and with one pump alone about 55% of rated capacity.

These pumps, Ingersoll-Rand Class 12BHVS, are single-stage, centrifugal units of the horizontally split, volute type.

• Keep Informed . . .

Casing is split on the horizontal centerline. Suction and discharge nozzles and pump feet are part of the lower half-casing. The upper half is easily removed to allow access to the working parts.

Shaft is extra-heavy to provide smooth operation. Within the pump, and through the stuffing boxes, the shaft is entirely covered by the impeller and protecting sleeves.

Efficient impeller is of the double-suction, volute type. It is sealed by double impeller rings of the shrouded type.

Bearings are of the Ingersoll-Rand self-aligning, sleeve type. A ball thrust bearing is incorporated in the outboard bearing housing. The bearings are oil-lubricated, and the bearing bodies are arranged for water-cooling.

Deep stuffing boxes seal the shaft. They are equipped with a sealing gland and a needle valve connection to the casing. Thus the oil being pumped may be used as sealing liquid in the stuffing boxes.

New Buoyancy-Type Instrument Both Controls and Indicates Liquid Level

With the announcement of its new Level-Buoy the Taylor Instrument Cos. of Rochester, N. Y., adds to its line a buoyancy-type instrument which both controls and indicates liquid level. The new instrument employs the Taylor Fulscope Control Mechanism with either completely Adjustable Sensitivity for smooth throttling level control, or Automatic Reset for averaging of liquid level with a minimum disturbance to the process.

Taylor
HIGH
LOW

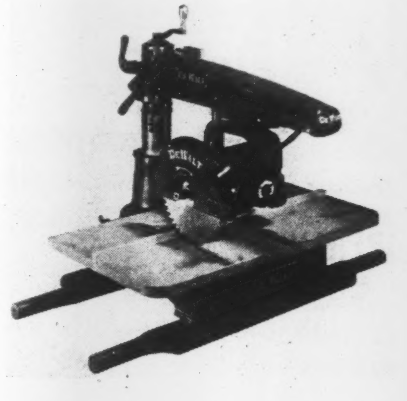
A torque tube transmits the level changes to the instrument mechanism. This eliminates a stuffing box with its need for lubrication or packing and gives a closed system which eliminates leakage. The torque tube is interchangeable with the ones used in the Taylor Aneroid Manometer which is a real advantage to instrument users in minimizing inventories of spare parts. There are no internal pivots to cause friction or wear.

The Level-Buoy handles liquids with specific gravities between .2 and 2.0. It is available in the following standard ranges: 14″, 32″, 60″, 72″ and 120″.

New Portable DeWalt Radial Saw

DeWalt Products Corp., Lancaster, Pa., originators and manufacturers of the well-known radial cutting machines, announce a new portable model, built especially for cutting right on the spot, thus saving materials handling, cutting time, and relieving manpower for other jobs. Ideal for use on the job or around the plant, since two men can easily carry it.

It will cross cut material 14″ wide × 1″, 12″ × 3″ with 12″ saw, and rip from 0″ to 26″ wide. It will also miter, rip, bevel cut off, double miter, and bevel rip. With such tools as dado heads, shaper cutters, router bits, and others, this machine is actually a woodworking shop in itself. In addition, the machine will cut light metals, ferrous and non-ferrous, when equipped with metal saw or abrasive wheel.



The unit features three simple DeWalt radial adjustments. The sturdy cantilever arm moves vertically, swings horizontally. The yoke rolls along the arm, rotates horizontally. The motor in it tilts at any angle. Regardless of the operation being made, the machine is perfectly balanced, since the weight of the motor is always in line with the center line of yoke, arm and column.

This new machine is available in $1^{1}/_{2}$, 2 and 3 hp. sizes. The direct drive motor is protected type, Formex Fiberglas insulated,

Continued on page 26

Polaroid*... Photoelastic Polariscope

for Stress Determination

To the machine designer, photoelastic stress analysis is not only of value in the verification of calculations based on theoretical solutions, but also in the solution of problems where theoretical analysis is not available. Where weight and space must be conserved actual stress distribution is more important than stress indicated by theoretical analysis.

In the new model polariscope of $4^{1}/_{4}''$ clear aperture, the parallel beam is collected by a rear element and condensed through a three component lens of the Cooke system. In the new larger unit ($8^{1}/_{4}''$ aperture) a four component lens of the Omnar system is used. *The image is sharp throughout the field, free of aberration, astigmatism and distortion.*

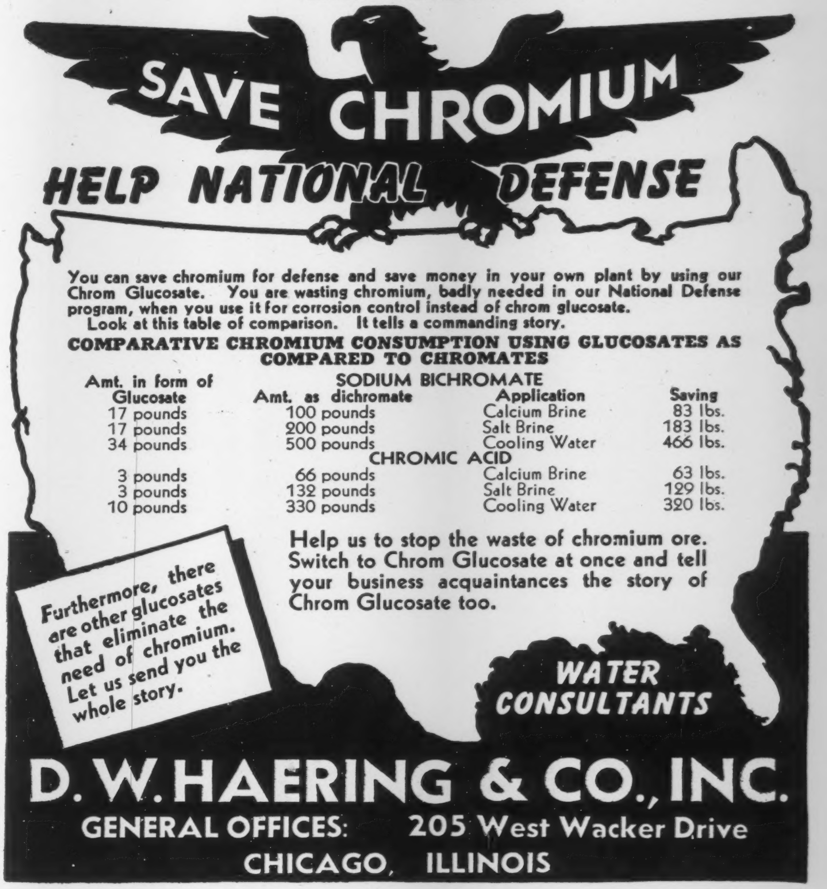
Literature of new model polariscope now available

POLARIZING INSTRUMENT CO., Inc.
1819 Broadway, New York 23, N. Y.

* *T. M. Reg. U. S. Pat. Off. by Polaroid Corporation*

TWO YEARS OF CALLING ATTENTION TO SAVING CHROMIUM

This advertisement ran in 1941



You can save chromium for defense and save money in your own plant by using our Chrom Glucosate. You are wasting chromium, badly needed in our National Defense program, when you use it for corrosion control instead of chrom glucosate.
Look at this table of comparison. It tells a commanding story.

COMPARATIVE CHROMIUM CONSUMPTION USING GLUCOSATES AS COMPARED TO CHROMATES

Amt. in form of Glucosate	Amt. as dichromate	Application	Saving
	SODIUM BICHROMATE		
17 pounds	100 pounds	Calcium Brine	83 lbs.
17 pounds	200 pounds	Salt Brine	183 lbs.
34 pounds	500 pounds	Cooling Water	466 lbs.
	CHROMIC ACID		
3 pounds	66 pounds	Calcium Brine	63 lbs.
3 pounds	132 pounds	Salt Brine	129 lbs.
10 pounds	330 pounds	Cooling Water	320 lbs.

Help us to stop the waste of chromium ore. Switch to Chrom Glucosate at once and tell your business acquaintances the story of Chrom Glucosate too.

Furthermore, there are other glucosates that eliminate the need of chromium. Let us send you the whole story.

D. W. HAERING & CO., INC.
GENERAL OFFICES: 205 West Wacker Drive
CHICAGO, ILLINOIS

Stuart's
Thred Kut
SOLVOL
"SUPER-KOOL"
CODOL

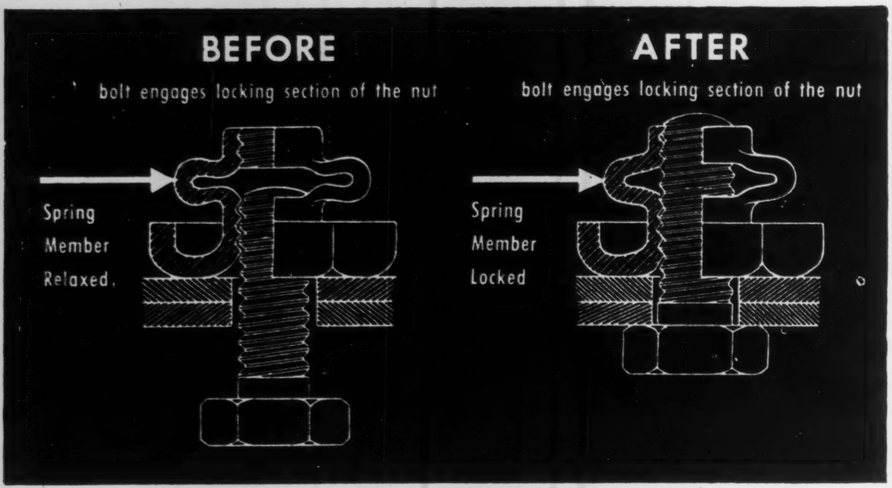
Begin with
the Finest
Cutting Fluids...

THEN APPLY THEM PROPERLY...

● Anything less than the best cutting fluids available is a handicap to your production. Equally important is *proper application.* Stuart Oil Products and Stuart Oil Engineering will give all the advantages it is possible to get from cutting fluids.

Stuart Oil
Engineering
Goes with every Barrel

For All Cutting Fluid Problems
D. A. STUART OIL CO.
Chicago, U.S.A. • LIMITED • Est. 1865
Warehouses in All Principal Metal-Working Centers


BEFORE
bolt engages locking section of the nut
Spring
Member
Relaxed.
AFTER
bolt engages locking section of the nut
Spring
Member
Locked

VIBRATION-PROOF NUTS

One-piece, all-metal construction gives Boots Self-Locking Nuts these distinct advantages over all other nuts: greater re-usability in maintenance; proof against corrosive action of oil, water and chemicals; resistance to high temperatures. Boots Nuts meet all specifications of government aviation agencies in an industry where loose fastenings will not be tolerated.

There's a BOOTS NUT for every application

ROL-TOP
BOOTS
ANCHOR
BOOTS AIRCRAFT NUT CORPORATION
GENERAL OFFICES, NEW CANAAN, CONNECTICUT

• Keep Informed

and provided with sealed ball bearings that require no lubrication.

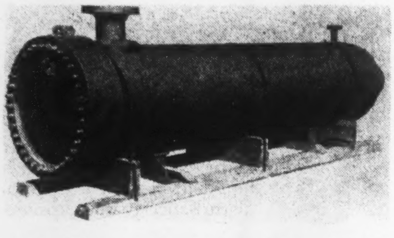
A new bulletin will be mailed without obligation. Write DeWalt Products Corp., 1000 Fountain Avenue, Lancaster, Pa.

Improved Design of Pipe Line Filters

The use of steel pipe lines for the transportation of crude oil and refined petroleum products dates back many years, but wartime needs for an uninterrupted flow of these materials has given great impetus to pipe line construction. Consequently, interest has been stimulated in the utilization of equipment which will permit the pipe line to function at its maximum efficiency. This means the maintenance of peak carrying capacity with minimum time out for cleaning.

Internal corrosion of pipe lines results in formations of solids and semi-solids which would normally be pumped through the pipe line. The physical structure of these solids varies from minute grains of silt to dirt particles of considerable size built up by accumulation while passing through the line. Naturally, this foreign material in the solid form causes obvious difficulties and damage to valve seats, pumps, and meters throughout the system, unless some provision is made to collect it and remove it from the line.

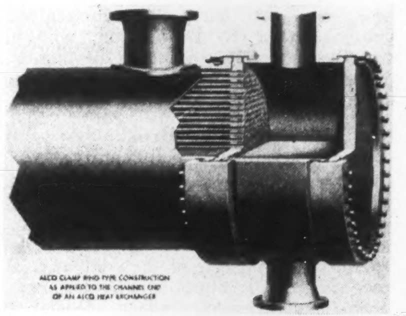
A conventional pipe line filter consists of a pressure cylinder having an inlet nozzle at one end, and an outlet connection at the top of the opposite end. The entire cross sectional area of the filter shell is packed with wood shavings, excelsior, or equivalent filtering medium through which the product flows on its way to the outlet connection from the filter. The packing and emptying of the filtering material is usually done through the restricted area of a manhole.

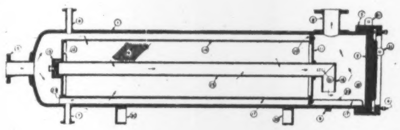


Alco Filters manufactured by the Alco Products Division of American Locomotive Co., 30 Church St., New York 8, N. Y., offer improvements in three essential features: (1) Increased filtering capacity, (2) Decreased time out for recharge of filter, and (3) Ease of dismantling and assembling.

Increased filtering capacity is achieved by (1) A radical reduction in the velocity of the liquid upon its entrance into the filter. As shown by the cross-sectional view, the shell space at the incoming end and around the perforated basket screen provides ample area for the heavier solids to deposit out at the bottom of the shell, before contacting the filtering media in the basket. (2) By directing the flow through the filter from the outside of the basket to the efflux pipe in the center, initial contact with the filtering media is made where its area is the maximum. This design permits Alco Pipe Line Filters to be kept on stream at full rated discharge capacity for longer periods of time than could be expected from conventional type filters.

Frequent recharging of any pipe line filter is, of course, a necessity. Consequently, any feature tending to lessen the time "off stream" is very desirable. The construction of the Alco Filter permits an absolute minimum "off stream" period. The bolts in the two-piece Alco Clamp Ring for attaching the cover plate can be quickly backed out, just far enough for the clamp to clear the beveled groove in the shell flange. The bolts remain in the clamp ring—none are lost and no time is spent searching for mislaid bolts. The Clamp Ring and Cover Plate are removed, tap bolts are backed out of Basket Retaining Flange, and the complete basket can then be withdrawn. Spare Filter Baskets may be kept on hand, packed and ready for use. When the pressure drop indicates that a change of filtering medium is required, the renewal can be made in exceptionally short time.


ALCO CLAMP RING TYPE CONSTRUCTION
AS APPLIED TO THE CHANNEL END
OF AN ALCO HEAT EXCHANGER



A study of the sectional view will reveal the simplicity of construction which so greatly facilitates dismantling and assembling of the various parts of the Alco Pipe Line Filter. The Filter Basket attaches to a retaining flange ring welded to the shell to prevent movement; at the same time this ring provides a separate compartment for the filtered product from which it passes out of the Filter. The removal of the single tap bolt in the rear end plate of the filter basket permits entire dismantling of the basket. Likewise, insertion of the tap bolt after refilling the basket completes the assembly of the component parts into a single rigid filter basket. This feature permits rapid discharging and refilling of the filtering medium.

The Filter Basket rests on guide tracks to center the basket in the shell and provide a space around the basket for the distribution of the incoming fluid, and the accumulation of sediment and solids below the basket. Guide tracks, as well as the end plates of the filter basket, are faced with non-ferrous material to prevent sparking when the Filter Basket is slid along the guides.

To facilitate handling of the Basket upon withdrawal from the Filter Shell, a specially designed carriage can be furnished if required. After the Alco Clamp and cover plate are removed, the carriage can be brought up to the end of the Filter and the Basket may be pulled out on the carriage with no danger of damage. This permits the basket to be moved to a convenient place for discharging and refilling of the filter media.

An elbow at the outlet of the efflux pipe directs the filtered products downward, thereby minimizing short circuiting of the flow to the outlet nozzle. The resulting agitation, particularly at the bottom of the channel reduces the contamination time on a products line installation.

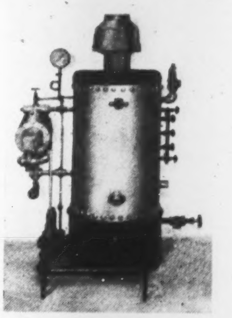
Alco Pipe Line Filters have been installed or contracted for, on several of the major pipe lines recently built or now under construction.

Continued on page 28

GAS FUEL RESTRICTIONS EASED:

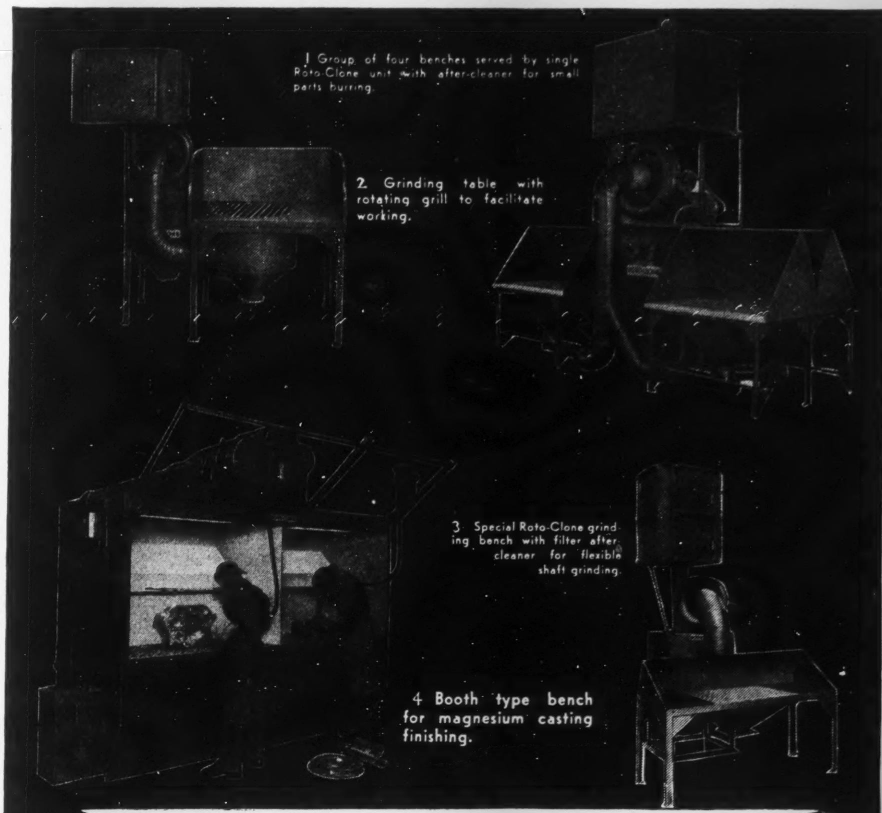
Small-Scale Use Now Permitted in Many Areas

During the past year the installation of additional gas-fired boilers has been generally restricted in areas where heavy fuel oils are used to manufacture gas. Now, however, the heavy fuel oil situation is improved and, on the other hand, coal is more scarce. As a result, the use of gas for small process steam installations is being permitted in areas affected by this changed condition, provided present generating facilities are not already being operated at capacity. *Your* community may be in such an area. So, if you need an additional small boiler, we suggest you check with your gas company or local W.P.B. office, then get in touch with us.



MKAYO Gas-Fired Boiler.
Sizes ¾ to 5 H. P. for 100 lbs. pressure.

MEARS KANE OFELDT
Manufacturers of Automatic Steam Boilers for over a third of a century.
1903-1915 EAST HAGERT STREET, PHILADELPHIA


1 Group of four benches served by single Roto-Clone unit with after-cleaner for small parts burring.
2 Grinding table with rotating grill to facilitate working.
3 Special Roto-Clone grinding bench with filter after-cleaner for flexible shaft grinding.
4 Booth type bench for magnesium casting finishing.

ROTO-CLONE

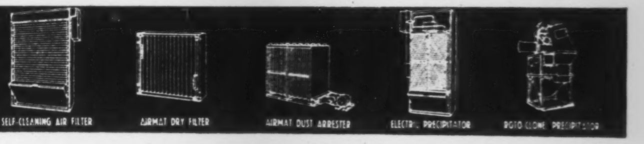
Dust Control

GRINDING BENCHES SPEED PRODUCTION

Shown on this page are some of the special AAF Roto-Clone grinding benches designed to meet specific needs in war production plants. Complete information on each will be sent on request.

AMERICAN AIR FILTER COMPANY, INC. 103 Central Avenue, Louisville, Ky.
In Canada: Darling Bros., Ltd., Montreal, P. Q.

AMERICAN AAF AIR FILTERS


SELF-CLEANING AIR FILTER
AIRMAT DRY FILTER
AIRMAT DUST ARRESTER
ELECTRIC PRECIPITATOR
ROTO-CLONE PRECIPITATOR

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CASTERS & WHEELS

A SAVING
AT EVERY
TURN

For light or heavy duty service Darnell Casters and Wheels are made for a long life of trouble-free usage

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192 Page
DARNELL
MANUAL
★

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LONG BEACH, CALIFORNIA,
60 WALKER ST., NEW YORK, N. Y.
36 N. CLINTON, CHICAGO, ILL.

• Keep Informed . . .

Air-Conditioning Equipment in One of the Nation's Most Interesting Plants

Huntington, West Virginia—In one of the nation's most interesting war plants, the Zenith Optical Co., air conditioning equipment is speeding the production of precision optical elements for the armed forces.

Described by the "Readers Digest" as having "done the kind of job with precision optics that Henry Kaiser has done with shipbuilding," Zenith Optical is an industry born of war emergency needs. Aiding in the mass production of precision opticals is equipment manufactured by Carrier Corporation, Syracuse, New York.

Explaining the use of air conditioning equipment under ideal conditions, Dr. L. M. Polan, Technical Director, states: "Optical elements are frequently mounted by means of pitch and wax, and must be held firmly in position in order to obtain true surfaces. If the temperature changes even a small amount, this material will warp, allowing the optical elements to become displaced, or put in a condition of strain. If the temperature drops sufficiently, the mounting material becomes hard and brittle, and the optical elements may be completely dislodged.

"When polishing glass surfaces against a pitch surface, it is important to maintain a specified constant temperature in order that the surfaces may become neither softer nor harder.

"Polishing is accomplished by a mixture of compound and water. At one stage of the operation, this compound is allowed to dry out with a comparatively small amount of moisture left on the surface. In order that this does not get out of control, it is important that the relative humidity and temperature of the air remain constant."

To fulfill these rigid requirements of temperature and humidity control Carrier has built and installed for Zenith an air conditioning system consisting of air conditioning units, refrigeration compressors and unit heaters, tailored to fit the peculiar needs of this plant. Although the major portion of the building is served by one system each department has its own individual control for maintaining the desired temperature and humidity.

In addition to manufacturing range finders and telescopic lenses, Zenith is reported to manufacture a large part of the optical products used in American tanks.

• *BUSINESS CHANGES*

Atkinson Appointed Vice-President Elastic Stop Nut Corporation

Luther H. Atkinson has been appointed Vice President in Charge of Sales of the Elastic Stop Nut Corp. of America, it was announced today by William T. Hedlund, President. Mr. Atkinson was formerly Vice President in Charge of Marketing for the Weyerhaeuser Sales Co. of St. Paul, Minn.

Titeflex Appointments

Titeflex Metal Hose Co., Newark, N. J., announces that John Dunn has been appointed Works Manager in charge of all plants of the Titeflex Co.

Formerly Production Manager at Titeflex, Mr. Dunn joined the organization in the year 1935. He had formerly been associated with the Westinghouse Electrical Manufacturing Co. at East Pittsburgh, Pa., the Otis Elevator Co., in Harrison. N. J., and the Bethlehem Shipbuilding Corp., in Elizabeth, N. J.

Succeeding Mr. Dunn as Production Manager is Arthur F. Pennington, who had formerly been Superintendent of plants at Titeflex, Mr. Pennington has been with the Titeflex organization since 1936.

Jenkins Bros. New Pittsburgh Representative

J. Murray Whitworth has been appointed to the Pittsburgh area as a sales representative of Jenkins Bros., manufacturers of valves, according to C. C. Chamberlain, general sales manager of the company. He succeeds John J. Simpson who resigned to become general sales manager of Pittsburgh Gage & Supply Co.

Mr. Whitworth, a graduate of Rhode Island State College, has been connected with

PROFESSIONAL
SERVICE
in ALL BRANCHES
of the ENGINEERING FIELD

Consulting Engineers
Engineering Organizations
Constructors—Contractors
Patent Lawyers, Etc.

Consultants on All Water Problems
Boiler, Process and Municipal Water ★ Waste and Sewage Disposal ★ Consultation ★ Design ★ Analysis
W. H. & L. D. BETZ
Frankford • Philadelphia • Pennsylvania

Power Plants and Electrical Distribution for Industry
Surveys, Reports, Design, Construction, Supervision.
EDWARD R. FEICHT
Bala-Cynwyd, Pa. (outside Philadelphia)

Chemical and Metallographical Laboratories—Welding . . . Supervision, Inspection and Testing, Qualification of Operators and Procedure.
THE JAMES H. HERRON CO., Cleveland, Ohio

Power Plants • New • Rehabilitation
Steam Generation — Diesel and Steam Power
Z. KOGAN, Consulting Service, — CHICAGO

Weld Testing—Qualification of Operators—Supervision—Inspection—Research.
NATIONAL WELD TESTING BUREAU
Pittsburgh Testing Laboratory, Pittsburgh, Pa.

Patents Obtained and Searched for any Invention in U.S. Patent Office.—Confidential Advice—Literature
Z. H. POLACHEK
Reg. Patent Attorney — Professional Engineer
1234 Broadway (31 St.) NEW YORK
Phone: Longacre 5-3088

Power Plants, Structures Transmission Systems—Design, Supervision, Inspection, Appraisals Reports.
SARGENT & LUNDY
140 S. Dearborn St., Chicago, Ill.

RATE **Announcements under this heading in MECHANICAL ENGINEERING are inserted at the flat rate of $1.25 a line per issue, $1.00 a line to A.S.M.E. members, minimum charge, three line basis. Uniform style set-up. Copy must be in hand not later than the 10th of the month preceding date of publication.**

the company's Philadelphia branch for the past seven years as a representative in Baltimore, Md. and Harrisburg, Pa.

In Pittsburgh he will be associated with L. V. McCune, Jenkins representative there for over 30 years.

Link-Belt Company Announces Promotions

W. C. Carter, president, Link-Belt Co., Chicago, announces the following promotions:

Edward J. Burnell, heretofore vice-president and general manager in charge of Pershing Road plant operations and central division sales, has been transferred to the Executive Office of the company, 307 N. Michigan Ave., Chicago (1). In his new position Mr. Burnell will be vice-president in charge of sales for the entire Link-Belt Co.

Directly assisting Mr. Burnell in his new post will be Nelson L. Davis, sales manager for materials handling machinery; William H. Kinkead, sales manager for power transmission machinery; and C. Walter Spalding, sales manager for power transmission equipment required by original-equipment manufacturers and duplicate machinery accounts.

Harold L. Hoefman, manager of the company's Atlanta plant, succeeds Mr. Burnell as general manager of the Link-Belt Pershing Road plant in Chicago.

Richard B. Holmes, district manager at Indianapolis, has been appointed manager of the Atlanta plant to succeed Mr. Hoefman.

David E. Davidson, district engineer at the company's Detroit office, has been named district manager at Indianapolis, to succeed Mr. Holmes.

Redmond Now Research Engineer for Kennametal

Kennametal Inc., Latrobe, Pa., has announced the appointment of John C. Redmond to the position of Research Engineer and Chief Analytical Chemist.

Mr. Redmond received his bachelor of science degree at Hamilton College, Clinton, New York, and his master's degree from George Washington University, Washington, D. C. His experience comprises many years as a chemist, first with the National Bureau of Standards and later with the Battelle Memorial Institute. Recently, he was associated with the Youngstown Sheet and Tube Co. where he was engaged in chemical analysis, research and process development.

Slaughter Now Vice-President, Votator Division, Girdler Corporation

Announcement was made recently of the election of John E. Slaughter, Jr., to the vice-presidency of the Votator division of the Girdler Corp. of Louisville, Kentucky. For the last five years he has been sales manager.

Starting in the New York office in 1934 as a salesman, Slaughter gained his first experience with Votator in its application to the ice cream industry.

He is a graduate of Male high school in Louisville. and of the University of Virginia.

Joseph B. Terbell Appointed First Vice-President of American Manganese Steel Division

The appointment of Joseph B. Terbell as first vice-president of the American Manganese Steel Division of the American Brake Shoe Co. has been announced by the company, with which he has been connected for fifteen years.

Continued on page 30

★ ★ ★ ★
★ FOR ★
SERVICE
"beyond the call of duty"
on the production front
★ ★ ★ ★ ★

THE STORY OF QUAKER PROCESS ENGINEERS

You'd naturally expect the man who sells you cutting fluids, grinding coolants, rust preventives and similar products to be able to make helpful suggestions on their use and application in your plant. But, if this is *all* you've come to expect, your first experience with a *Quaker Process Engineer* will undoubtedly be somewhat of a surprise. For these highly trained men are constantly distinguishing themselves on the production front by rendering "service *beyond* the call of duty."

One of our men, for example, recently devoted several days to the designing of a permanent mold for a customer who was stymied by this particular problem. Another Quaker Process Engineer *spent several weeks in a customer's plant studying and locating the reason for a baffling drop in machining results on a certain airplane part.*

In fact, it is not at all uncommon to find a *Quaker Process Engineer* serving as a consultant on the layout of a new processing system . . . or sitting in with a laboratory or engineering staff to work out a new manufacturing process.

MUST MEET RIGID QUALIFICATIONS

To qualify as a* Quaker Process Engineer *a man must be a graduate chemist and/or engineer and must have had at least five years' experience in process and production work in the metal manufacturing industry. He is, therefore, intimately acquainted with the operations which Quaker Chemical serves with its products. He is then given additional training in our laboratories and in the field . . . so that he knows thoroughly Quaker* engineering methods *and* products *. . . and how to apply them to get maximum production.

With such a wealth of training and experience, a *Quaker Process Engineer's* help can often be extremely valuable in curing troubles—whether connected with processes served by Quaker Chemical products or some other process in a metal manufacturing plant.

SPIRIT OF FRIENDLY HELPFULNESS

Why do we permit—even encourage—our men to devote so much time to "service beyond the call of duty"? Simply because our whole business philosophy here at Quaker is based on a spirit of friendly helpfulness . . . and the conviction that, in the long run, we will benefit by serving our customers to the fullest extent of our ability.

It is part of the same spirit of service to industry which led us, years ago, to dedicate our extensive research facilities to the task of locating processing problems which we felt had never been handled quite satisfactorily . . . and of developing new products or processes to overcome these troubles.

LABORATORY, NEW PRODUCTS AT HIS SERVICE

The facilities of our research laboratory—and the many new type products which have come out of it—stand behind your local* Quaker Process Engineer *. . . to help him solve your production problems or improve present results. So why not call him in and get acquainted? You'll find him an interesting, friendly sort of fellow . . . with a fund of useful knowledge on which you can draw. Simply write or wire—

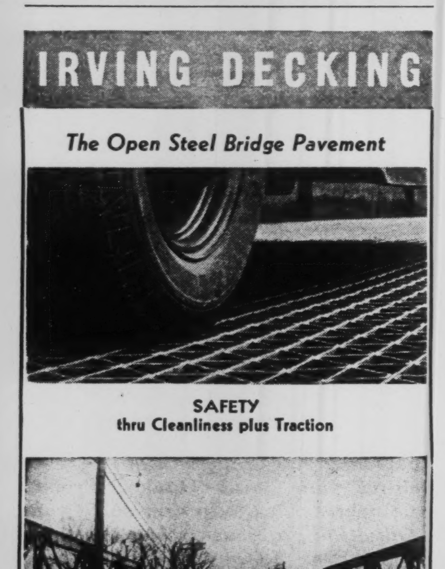
QUAKER CHEMICAL PRODUCTS CORP.
CONSHOHOCKEN, PA.
Other Plants in CHICAGO and DETROIT...Warehouse Stocks in Principal Industrial Centers

Turbine Driven IMO Pumps

Depending upon viscosity and other conditions, the De Laval-IMO Oil Pump can either be coupled directly to the shaft of a steam turbine or through a speed reducing gear, as here shown. This unit is designed for continuous service, the turbine having its own "lube" oil pump, oil cooler, filter, and rate-of-flow indicator, and being protected by a mechanical governor and a pressure release valve. The main pump has only 3 moving parts, and no valves, gears or cams. It is perfectly balanced, both hydraulically and rotationally and the discharge is free from pulsation.

Ask for Publication I-109.

IMO PUMP DIVISION
of the De Laval Steam Turbine Company
Trenton, New Jersey


IRVING DECKING

The Open Steel Bridge Pavement

SAFETY
thru Cleanliness plus Traction

ECONOMY
thru Lightweight plus Durability

ESTABLISHED 1902
IRVING SUBWAY GRATING CO., INC.
HOME OFFICE and PLANT: 5010 27th STREET
LONG ISLAND CITY 1, NEW YORK
WESTERN DIVISION: FOOT OF PARK AVENUE
EMERYVILLE 8, CALIFORNIA

• Keep Informed . . .

Mr. Terbell was born in 1906 and graduated from the Sheffield Scientific School of Yale University in 1928.

In October, 1928, he joined the American Manganese Steel Division. After serving an apprenticeship of about two years in the Chicago Heights plant, he entered the Chicago sales office and sold both Manganese Steel and Amsco Alloy castings. During 1931 he was transferred to the Ramapo-Ajax Division; but the following year was transferred back to the American Manganese Steel Division's New York office, where he worked mostly with alloys and welding rod sales.

In 1933 Mr. Terbell moved to St. Louis as assistant manager of the alloy department, then located at the St. Louis plant. In 1935 he went to Chicago in the sales department; and during 1936 was transferred for a brief period to the American Forge Division. He came back to Amsco again in 1937, being located in the New York office as eastern sales manager.

In 1940 Mr. Terbell was appointed a vice-president of the American Manganese Steel Division, and now has been designated as first vice-president of that American Brake Shoe Co. unit.

Weaver Heads New Marine Department of Westinghouse

To best serve the expanding maritime field, the formation of a separate marine industry department by Westinghouse Electric and Manufacturing Co. is announced by F. H. Stohr, Manager of Industry Departments.

Mr. Charles H. Weaver is appointed manager of the newly formed Marine Department, and will direct all commercial activities. This responsibility includes the coordination of marketing of the diversified products of the Company that are used for marine service.

Mr. Weaver, as former manager of the Marine Section of the Industrial Department is well known in the marine industry. He was born in Philadelphia and graduated from the University of Pennsylvania in 1936 with a degree of Bachelor of Science in Electrical Engineering. He joined Westinghouse as a member of its student course in 1936. Two years later he was placed in the sales department of the generator division, remaining there until 1940 when he was transferred to the Marine Section of the Industrial Department.

Martz Now Assistant to President, Micromatic Hone Corp.

Lawrence S. Martz has been named Assistant to the President of Micromatic Hone Corp., Detroit, Mich., manufacturers of honing machine tools and associated honing equipment. Mr. Martz joined the Micromatic organization in 1934, and has served since in the engineering, sales engineering, publicity and technical service departments. He will continue to direct technical service activities, and will also coordinate the company's human and public relations program.

Named Assistant to Westinghouse Vice President

W. G. Marshall, vice president of industrial relations at the Westinghouse Electric & Manufacturing Co., has announced the appointment of C. A. Smith as assistant to Thomas I. Phillips, vice president of the East Pittsburgh Divisions.

Mr. Smith, who has been with the Company for 51 years, was manager of Factory Service at the East Pittsburgh Plant prior to his appointment. In his new capacity, he will assist Mr. Phillips in the administration and coordination of manufacturing activities.

Joining Westinghouse in 1892 as an apprentice, Mr. Smith has, since that time, served as assistant foreman, general foreman, assistant superintendent, superintendent and division manager.

Allegheny Ludlum Creates Carbide Division

W. F. Detwiler, Chairman of the Board of the Allegheny Ludlum Steel Corp., Brackenridge, Pa., has announced his company's recent acquisition of the Carbide Alloy Corp. of New York City. The property will henceforth be operated as Allegheny Ludlum's Carbide Division.

As a leading producer of all kinds of special steels, Allegheny Ludlum has for years maintained the policy of establishing new facilities wherever and whenever necessary to better service new customers, according to Mr. Detwiler.

"A case in point occurred only a few months ago," he said, "with the establishment of our Los Angeles Manufacturing Division, having as its basis the mounting importance of the West Coast as a special metals consuming area.

"The new Carbide Division," he added, "recognizes late developments in the field of metal-working, and is calculated both to round out and enhance Allegheny Ludlum's service to the fabricating industries of the country. It should prove to be a matter of major benefit under the necessities of rush

COMING MEETINGS AND EXPOSITIONS

During the next three months

DECEMBER

1–2	**American Management Association, Insurance Conference, Statler Hotel, Chicago, Ill.**
6–8	**American Society of Agricultural Engineers Fall Meeting, La Salle Hotel, Chicago, Ill.**

JANUARY

10–14	Society of Automotive Engineers, Annual Meeting and Engineering Display, Book-Cadillac Hotel, Detroit, Mich.
12–13	American Management Association, Marketing Conference, Waldorf-Astoria Hotel, New York, N. Y.
24–28	American Institute of Electrical Engineers, National Technical Meeting, Engineering Societies Building, New York, N. Y.
25	American Boiler Manufacturers Association and Affiliated Industries, Mid-Winter Meeting, Hotel Cleveland, Cleveland, Ohio
31–Feb. 2	American Society of Heating and Ventilating Engineers, Fiftieth Annual Meeting, New York, N. Y.

FEBRUARY

20–24	American Institute of Mining and Metallurgical Engineers, Annual Meeting, Waldorf-Astoria, New York, N. Y.
9–11	American Management Association, Personnel Conference, Palmer House, Chicago, Ill.
10–11	The Engineering Institute of Canada, 58th Annual Meeting, Chateau Frontenac, Quebec City, Canada
14–17	Technical Association Pulp & Paper Industry, Annual Meeting, Commodore Hotel, New York, N. Y.

For Calendar of coming A.S.M.E. Meetings see page 924 in the editorial section.

• Keep Informed

war production, and of no less importance in the peacetime aftermath."

Initial products of the company's new manufacturing division will be a line of highly developed cemented carbides, produced under processes established by Carbide Alloy Corp.

"Later activities of the division will probably take into account developments which have long been under study in Allegheny Ludlum's Research Laboratories," Mr. Detwiler stated.

The company's expansion into the carbide field is also a reflection of its intensive work in the field of cutting materials in general, Mr. Detwiler pointed out. Two research developments of undoubted importance to war production have preceded it: the introduction and subsequent free release to the nation of DBL High Speed Steel, which has been credited as the chief factor in the vital tungsten conservation program; and the later development of the Super DBL analysis, which carries the advantages of tungsten saving into the field of heaviest production cutting. In addition, Allegheny Ludlum was one of the prime movers in the development of the so-called "moly" high speed steels, which likewise have played a strong role in the war program.

Floyd Resumes in Allegheny Ludlum Chicago Office

Paul E. Floyd has returned from Washington to resume his former position as District Manager in the Chicago Branch office of the Allegheny Ludlum Steel Corp., according to Russell M. Allen, the company's General Manager of Sales.

For more than a year past, Mr. Floyd has filled a responsible post in the Iron & Steel Branch of the War Production Board. Allegheny Ludlum had granted him a leave of absence for the purpose in early 1942, at the war agency's request, and Mr. Allen stated that WPB recently consented to release Mr. Floyd in order that he might return to active duty in his former capacity.

• LATEST CATALOGS

AGMA Recommended Practice Featured in New Falk Motoreducer Bulletin

To simplify the selection of correct gearmotor units for specific applications, The Falk Corp. of Milwaukee has published a new Motoreducer Bulletin No. 3100. The bulletin is set up in conformance with Standard Practice of the American Gear Manufacturers Association which allows for three distinct classes of units dependent upon various service factors.

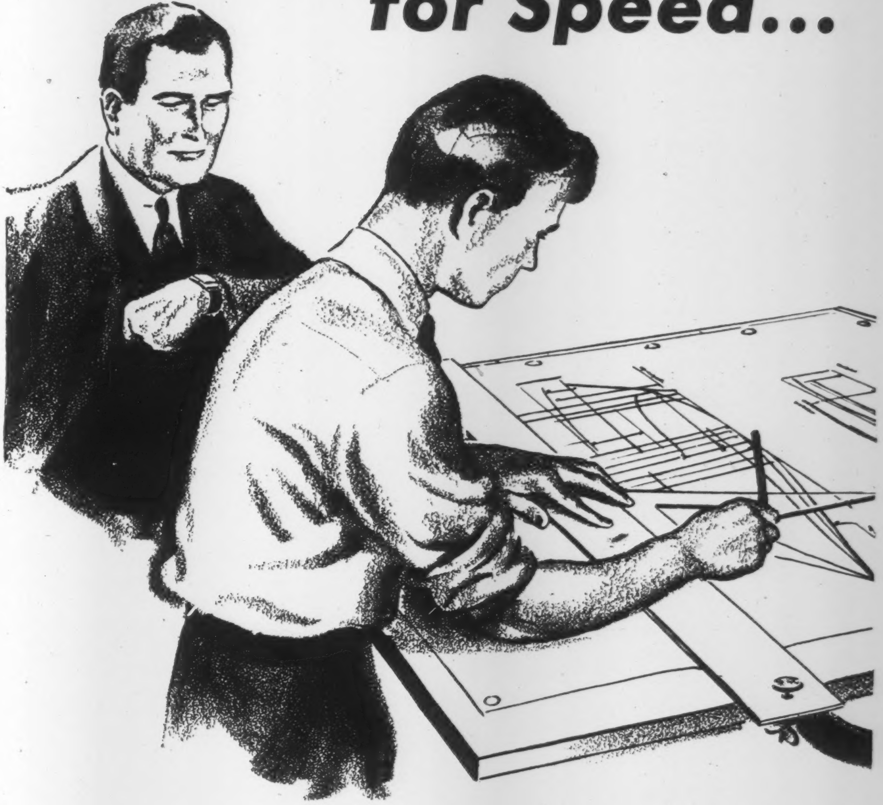
Methods of selection, selection tables, and complete dimensions for every size and type of unit are other features that make this 64-page bulletin a valuable reference for industrial engineers, designers, and purchasers of machinery. A free copy will be mailed to those requesting it on their company letterhead. Write direct to The Falk Corp., 3001 W. Canal Street, Milwaukee 8, Wisconsin.

Stainless Steel Flexible Tubing and Bellows

A new illustrated engineering manual (SS-44) on Rex-Flex Stainless Steel Flexible Tubing and Bellows has just been issued by Chicago Metal Hose Corp of Maywood, Ill. This manual contains much engineering data

Continued on page 32

The greater the need for Speed...



. . . the greater the need for

ARKWRIGHT TRACING CLOTHS!

• If you're working under pressure, use Arkwright Tracing Cloths. Then you won't have to worry about erasures. You can erase easily and quickly because Arkwright Cloths have a smooth, almost smudge-proof surface. And you can ink over erasures neatly because both surface and base cloth are strong enough so they won't wear through. When time is important, choose tracing cloths carefully. Choose Arkwright! Arkwright Finishing Company, Providence, R. I.

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PENCIL TRACING CLOTH
TRACING CLOTH

Arkwright TRACING CLOTHS

AMERICA'S STANDARD FOR OVER 20 YEARS

and specifications not heretofore published. Characteristics of the product are shown in detail, with tables of sizes, weights, wall thicknesses of the various wall forms, together with pressure data, minimum bending radii and a wealth of other detail useful to the engineer. Complete data on fittings is also given, with diagrams and instructions for attaching fittings, and recommended design procedure for various types of applications. One feature of special interest is the double page spread giving, in chart form, line-loss data on Rex-Flex Tubing and Elbows. There are many detailed photographs and illustrations of new interest to design, production and maintenance engineers in the 36 pages of this new two-color book. Published by Chicago Metal Hose Corp., Maywood, Illinois.

Axial Flow Fans

Aerovent Fan Co, have just issued a new 52-page catalog showing their complete line of axial flow industrial ventilating fans.

Many new diagrams and illustrations with the accompanying text explains clearly the advantages of the various types available.

Full engineering and technical data have been included in this new two-color catalog which can be obtained by writing the Aerovent Fan Co., 710 East Ash Street, Piqua, Ohio.

"The Story of the Turbine"

Part of the series of booklets dealing with the history of the General Electric Co., its research and engineering activities and its contributions to American progress, a 24-page illustrated "Story of the Turbine" has been released by the Company and is being offered to the general public.

The publication, GEB-129, is a summary of the highlights in the development of the steam turbine that today produces most of the nation's electric power and drives many of America's naval and merchant ships. Written primarily for the layman, the booklet includes little technical discussion. It is, rather, an explanation of the place the turbine is now filling in war production and will fill in America's peacetime living.

"The Story of the Turbine" is available from the General Electric Co. at Schenectady, N. Y.

"Flow Meter Engineering"

"Principles and Practice of Flow Meter Engineering," by L. K. Spink, published by The Foxboro Co., Foxboro, Mass. Price $3.

This handbook, widely accepted as a standard text and guide, has just appeared in a new and enlarged edition, the sixth since the book was first published in 1930. New and advanced phases of the subject are covered for the first time, bringing the book up to date and adding to its usefulness. The author, L. K. Spink, is a member of the working committee which developed the latest AGA orifice meter tables, a member of the ASME Fluid Meter Research Committee, and of the joint AGA and ASME Pulsation Research Committee. As an engineer who has devoted many years to the study of flow measurement, he is extraordinarily qualified to handle the subject.

The book, 232 pages in length, is illustrated with photographs, diagrams and curves, and contains all the tables and formulæ needed for any ordinary liquid or gas flow computation. In the Liquid Section, methods for determining compressibility factors of liquids at temperatures near the critical, a new and more accurate method of correlating temperature expansion data on petroleum oils, a quick method of correcting for tap locations, and a short-cut method of correcting for viscosity, are some of the features.

The Gas Section suggests several methods of correcting for viscosity effects. Theoretical discussion, as well as working equations and tables for moisture and supercompressibility, are presented. A new and simple type of intermediate pressure device which eliminates the by-passing of gas is described. The latest findings on the measurement of pulsating gas flows are covered.

"Principles and Practice" is a thoroughly practical handbook, recognized and used by men in the field as well as by technical institutes. Many large industrial concerns depend on it, considering it to be the most complete, accurate and workable publication on the measurement of gas and liquid flows that is available today.

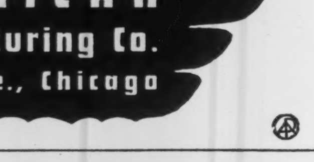
Ball Bearings in the War

To give people a quick picture of the importance of ball bearings in this highly mechanized warfare, the New Departure Division of General Motors has issued a little booklet profusely illustrated with the various types of ball bearings used in aircraft, tanks, trucks, ships, etc. These bearings range in size from those a little larger than the head of a common pin for the pivots of aircraft instruments, to the thirty-three pound differential bearings of medium tanks and include such unusual installations as 61 in the Norden Bombsight and 3,469 in the M-1 Seacoast Computer for directing the fire of our largest coast defense guns.

What do you know about Vibration?

1. It is a destructive force that takes a tremendous toll, probably resulting in the scrapping of more peacetime and war materials and equipment than all the other causes combined.
2. Rapid strides have been made in overcoming the destructiveness of vibration, by research — shakedown tests to determine how much vibration a part or assembly can endure, followed by redesigning.
3. All American Vibration Fatigue Testing Machines reproduce the vibrations encountered in aircraft, military vehicles and industrial machines, as faithfully as it is possible to simulate them.

A treatise on Vibration Fatigue Testing and a nomograph which facilitates calculation of the various factors embodied in tests, is contained in our Catalog F, which also shows our various models designed for every laboratory and inspection department requirement.

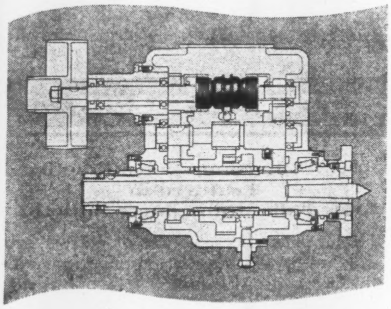


Model 25A for testing parts up to 25 lbs. Has automatic frequency changing device.

ALL AMERICAN
Tool & Manufacturing Co.
1014 Fullerton Ave., Chicago

How the PULLMORE Clutch "inches" the work or cutter along

Where the shaper, lathe or miller operator wants to "inch" the work or cutter along, the PULLMORE clutch provides selective, idling and reverse speeds. The lathe head application at the right shows how compactly the PULLMORE clutch fits into the machine tool design.



Send for These Power Transmission Bulletins

Contain useful application designs. Give capacities, dimensions and specifications. Show exclusive PULLMORE features that help engineer stand-out equipment.

Let our engineers help you design power transmission applications that will give your products competitive advantages.

ROCKFORD DRILLING MACHINE DIVISION
1307 Eighteenth Ave., Rockford, Ill., U. S. A.

A division of BORG-WARNER
DESIGN IT BETTER
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Machine Tools
Process Machinery
Farm Implements
Materials Handling
Earth Movers
Service-Machinery
Power Units

Pullmore Multiple-Disc Clutches • Over-Center and Spring-Loaded Clutches • Power Take-Offs

• Keep Informed

The booklet also illustrates New Departure's many "Famous Firsts" such as the first bicycle coaster brake, the Yellow Taxicab, the Rockwell hardness tester, automobile engines with cylinders cast *en bloc*, bearings with their own oil-circulating system, and many other "new departures by New Departure."

Those interested may have copies by asking for Booklet WW from New Departure's Advertising Department at Bristol, Conn.

"The 577th Oil"

"The 577th Oil" is the title of a sixteen-page booklet just issued by D. A. Stuart Oil Co., manufacturers of industrial and automotive oils. It features twenty-two short stories of how proper cutting fluids have solved production problems in war plants manufacturing products ranging from tanks to hypodermic syringes. It also contains other information on metal-working including tips on prolonging tool life, and a chart helpful in adapting sulpho-chlorinated oils to various metal-working operations, tools and metals. For free copies write to D. A. Stuart Oil Co., Department ME, 2727 South Troy Street, Chicago 23, Illinois."

Steam Traps

"Armstrong Steam Trap Book"—a catalog and educational handbook on condensate drainage; presenting data, pictures and diagrams on standard traps, forged steel traps, blast traps, compound traps, refrigerant gas purgers, unit humidifiers, and special equipment. Also data on trap accessories, sizing information and recommended practices. Armstrong Machine Works, Three Rivers, Mich.

Ampac "400" A-C Welder

Benefits to war industry of the new Ampac "400" a-c welder are outlined in a 4-page bulletin released by Allis-Chalmers.

Comparative advantages of the 400 ampere size of welder to the purchasing agent, the welding engineer and the welder himself are told in this bulletin.

A pictorial section shows for the first time the step-by-step construction and internal assembly of a continuously variable heavy duty a-c welder. Graphs compare idling loss and efficiency of the Ampac "400" with two of the best-known a-c welders in 300 and 500 ampere sizes and with a typical d-c welder. Complete electrical performance data on this unit at all loads are also given.

For copies of Bulletin B-6302, write Allis-Chalmers Mfg. Co., Milwaukee, Wis.

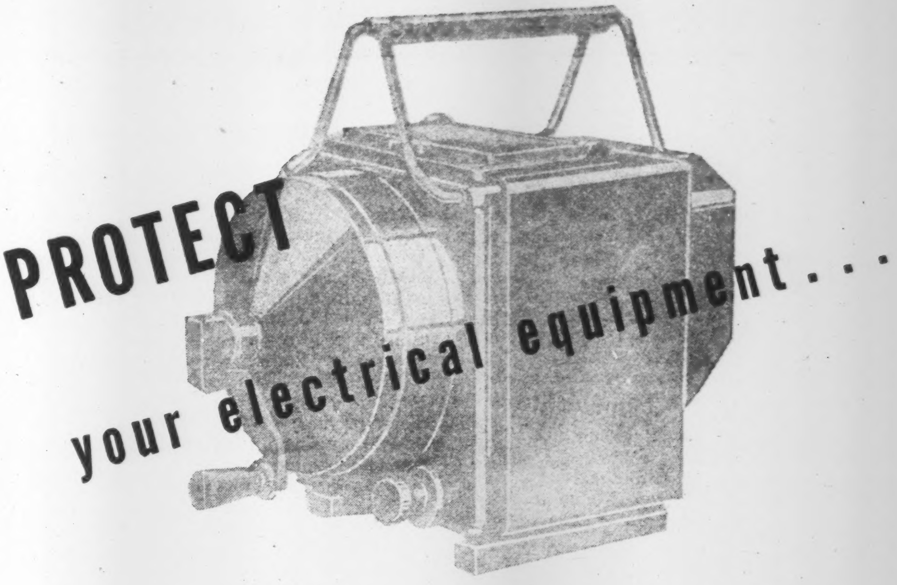
Piston-Ring Expansion Joint

A new 14-page $8^1/_2 \times 11$ illustrated "Adsco" Bulletin No. 35-15C on the "Adsco" Piston-Ring Type, slip expansion joint, which can be completely unpacked and repacked under full operating pressure, giving details of construction dimensions and list prices in sizes from $1^1/_2''$ to $20''$ for steam pressure to 400 lbs. has been issued by the American District Steam Co., North Tonawanda, N. Y., from whom a copy may be obtained upon request.

Relay Types and Their Applications

The purpose of this bulletin is to provide the electrical engineer with a quick reference to standard relay types and assist him in making a preliminary selection without the necessity of sifting more detailed and time consuming descriptions. Thumb nail descriptions suggest applications, give contact ratings and combinations, power require-

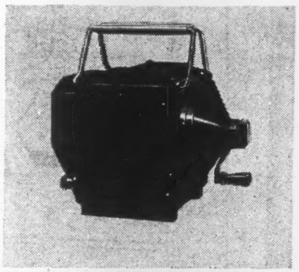
Continued on page 34



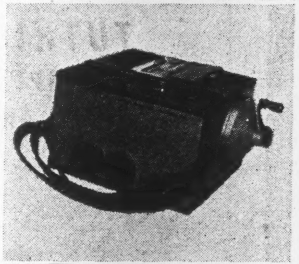
. . . use "MEGGER" Insulation Testing Instruments

These remarkable instruments should be used by every maintenance man who is seriously interested in forestalling electrical failures. They detect moisture, dirt and deterioration in the insulation of practically all types of electrical equipment. Having hand-cranked generators they require no batteries or adjustments and are wholly independent of external circuits. Ready for use anytime—anywhere.

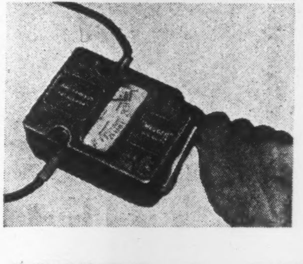
If you are not aware of the protection afforded by the use of "Megger" instruments and their importance in keeping electrical equipment in operation, write today for the Pocket Manual of "Megger" Practice, No. 1420-M.



THE NEW U. S.-MADE "MEGGER" INSULATION TESTER—Consists essentially of a direct-reading true ohmmeter of the permanent magnet moving coil type mounted with a d-c hand generator in a plastic molded case. Ranges up to 1000 megohms, with hand generators up to 500 volts. Widely used in hard service. Variable-pressure ("Meg") and constant-pressure ("Super-Meg") types. Bulletin 1735-M.



THE "BRIDGE-MEG" RESISTANCE TESTER—This instrument is a combined "Megger" Insulation Tester and a four-dial, multi-ratio Wheatstone Bridge. Will measure any ohmic resistance from .01 ohm up to 100 or 200 megohms; hand generators rated up to 1000 volts. A complete and compact resistance measuring unit that is ideal for power companies and industrial plants. Catalog 1685-M.



THE MIDGET "MEGGER" TESTER—In many ways the most remarkable "Megger" instrument ever built. Weighs only 3 lbs.—will fit an overcoat pocket or tool kit. Reads up to 50 megohms. Generates 500 volts and is always ready to use anywhere because of the hand crank. Send for Catalog 1685-M.

JAMES G. BIDDLE CO. • 1211-13 ARCH STREET
PHILADELPHIA 7, PA.

ments, size and weight of 17 types of relays used in aircraft, radio, Signal Corps, and general industrial applications. A short explanation of two popular time delay methods is also included. Another section tells about the new lightweight solenoid contactors built to U. S. Army Air Force specifications. Following this, is a paragraph on solenoids giving plunger stroke, lift, and power requirements for 8 standard types of intermittent and continuous duty A.C. and D.C. solenoids. Ask for Bulletin OF112. Guardian Electric Mfg. Co., 1619 W. Walnut Street, Chicago, Illinois.

Drafting Room Equipment

The Hamilton Manufacturing Co., Two Rivers, Wis., offers a new catalog of Drafting Room Equipment . . . streamlined for war.

This new catalog features items of wood construction, embodying features found previously only in steel equipment.

Engineering departments requiring additional drafting room equipment will be interested in the Liberty Line . . . Victory wood units that interlock with and match steel units in color and design . . . the Wood Auto-Shift drawing table with its time and energy-saving features . . . drawing boards . . . tracing tables and portable tracing boards and accessories.

For complete information, write the Hamilton Manufacturing Co. for a copy of the new Liberty Line Catalog, No. 13.

New Reeves Pulley Catalog

Reeves Pulley Co., METR-452, Columbus, Ind., are now issuing a brand-new 128-page general catalog, G-435, which completely describes all "Reeves" Variable Speed Control Units—The Transmission, the Vari-Speed Motor Pulley and the Motodrive.

It is honestly believed that this constitutes the most comprehensive book on variable speed control ever published, and contains many specific examples, illustrations, revised dimension diagrams and engineering tables. It shows how variable speed control can be applied to all types of production machines to step up output and improve processing.

Complete details are given on recent additions and improvements to the "Reeves" products, including the new Reducer-Type Transmission, which provides speed variation and reduction in one compact unit; the Vari-Speed Jr., which furnishes accurate speed control on light machinery; and the improved Differential unit.

Also, there is latest information on new automatic controls, and on the "Reeves" Speedial Handwheel.

The catalog, G-435, is very attractive with a dark brown cover, embossed in gold, and an ivory plastic binder.

Pipe Tools

Beaver Pipe Tools, Inc., Warren, Ohio, announce their new 1944 catalog, fresh from the press. This new catalog is much more complete than any previously issued—in that it gives broader coverage to the Beaver Line of Pipe Tools, and more clearly dissects Beaver Tools and Machines for the benefit of the buyer. A number of downward price changes have been made in this catalog. All prices conform to the OPA Price Regulation.

Copy of their condensed catalog, used so freely by jobbers' salesmen in their loose-leaf books, and by jobbers in passing out to the interested trade, is also fresh from the press.

Prices given are "net users" so that the buyer will have little difficulty in knowing the price at which Beaver product may be bought through any leading supply house.

Fan Circulation Electric Unit Heaters

The Hynes Electric Heating Co. have brought out many new types of fan circulation electric unit heaters and flanged heater sections for installation in air ducts. These are available in any desired rating and for all commercial voltages and for a wide application in heating of buildings and for industrial process work.

Further information about electric air heating units of any type can be obtained by writing to the Hynes Electric Heating Co., West & Clinton Sts., Camden, N. J.

New Humidifier Bulletin Announced

A new illustrated booklet presenting engineering data and complete details on unit steam-type humidifiers is now available from Armstrong Machine Works, Three Rivers, Michigan.

This booklet shows results obtained by automatic humidification for prevention of loss of weight, strength, or quality in hygroscopic materials; for improving workability of materials; for controlling drying processes; for static control to prevent explosion hazard with dust and inflammable liquids and gases; and air conditioning service for maintaining healthful and comfortable working conditions. Also included are operating features, installation data and other information on these units, which sell for as low as $100.00 complete for 40,000 cu. ft. capacity.

McGILL SOLIDEND MULTIROL BEARINGS offer a "plus"

You get more than "a bearing" when specifying McGILL "Solidend" MULTIROL. You get greater load capacity, provision for incidental thrust, bearing rigidity, high carbon chrome steel, and the elimination of end-washers and loose retaining rings. Thus, you are assured of a lower initial, operating and maintenance cost and at the same time an improved bearing performance.

For complete details and specifications of McGILL "Solidend" MULTIROL Bearings, send for bulletin SM-42.

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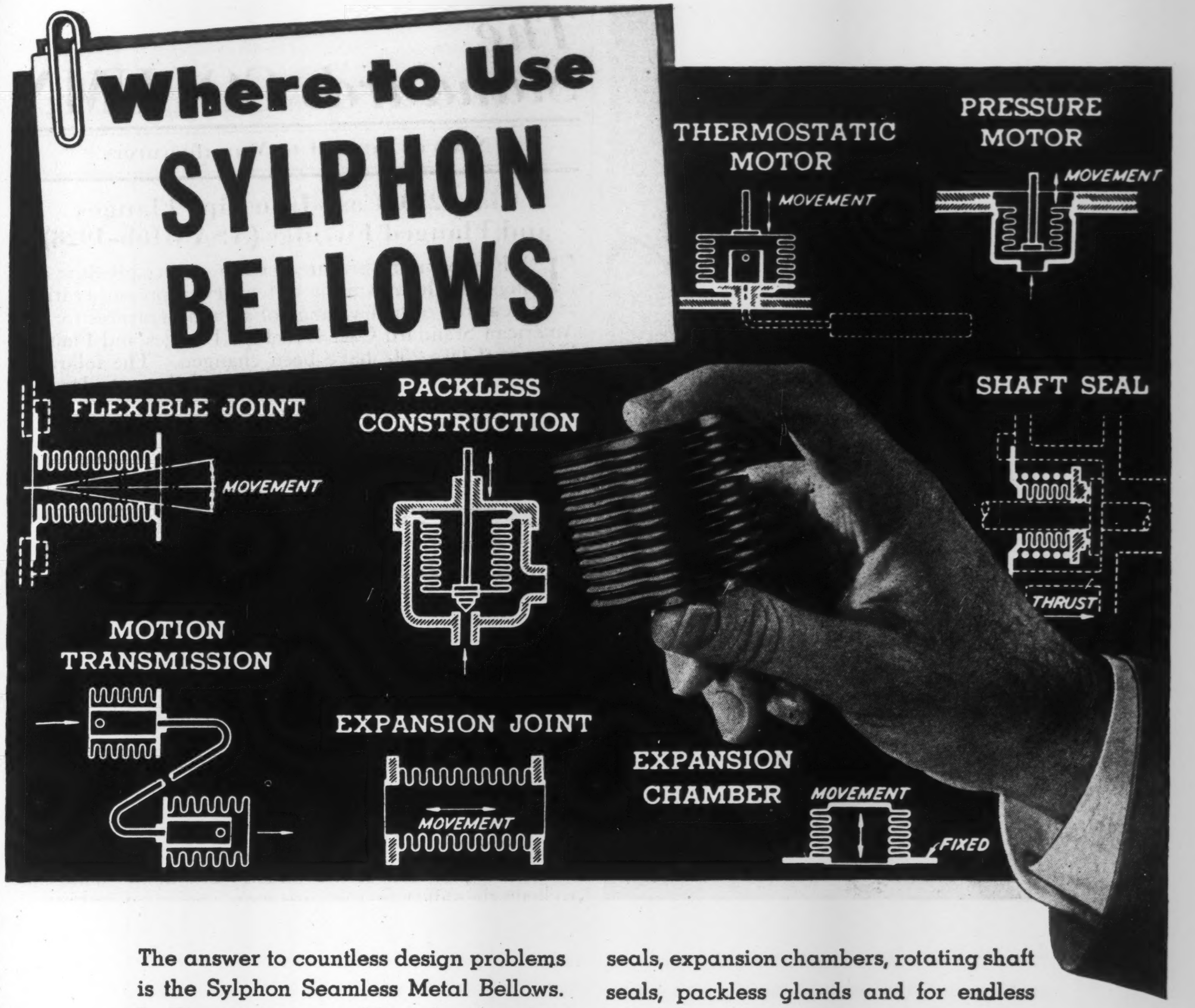

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THRUST
MOTION TRANSMISSION
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The answer to countless design problems is the Sylphon Seamless Metal Bellows. In Thermostat assemblies, for instance, this amazing Sylphon Bellows helps solve the problems of temperature control in internal combustion engines, diesels, refrigeration and air conditioning, heating and ventilating, and many phases of industrial processing.

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KNOXVILLE, TENNESSEE

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U. S. Army Air Corps

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The Standards COLUMN

News of Interest to Manufacturers

Class 250, Cast-Iron Pipe Flanges and Flanged Fittings (ASA B16b-1928)

THE maximum saturated steam service pressure ratings and the maximum water service pressure ratings at or near the ordinary range of air temperatures for the American Standard Cast-Iron Pipe Flanges and Flanged Fittings, Class 250, have been changed. The following table gives the rating of these flanged fitting standards as given in the present standard, dated February, 1928, and the revised ratings as given in the present revision now before the sponsor bodies.

SIZES	MAX. STEAM RATINGS IN 1928 STANDARD	MAX. STEAM RATINGS IN PROPOSED REVISION	MAX. WATER RATINGS OF PROPOSED REVISION
1 to 12 in. incl.	250	250 psi	400
14 to 24 in. incl.*	250	200 psi	300*
30 to 48 in. incl.*	. . .	100 psi	300*

* FLANGES ONLY

This revised edition of ASA B16b-1928 was prepared by Subcommittee No. 1 of Sectional Committee B16 to bring the standard into line with up-to-date practice in the manufacture and use of these fittings. Corrections were made in the wall thicknesses of sizes $2^1/_2$ in. and smaller to establish the actual minimum dimensions that have been in practice with cast iron. Wall thickness tolerance was included also to cover established inspection requirements. The downward revision of the steam and water service pressure ratings was done to satisfy the needs and practices of the industry and at the same time to keep the safety factors on a more conservative basis.

The lists of sizes of the various types of fittings were reduced somewhat. This applies to crosses, side-outlet elbows, side-outlet tees, laterals, true YY's, eccentric reducers, and anchorage fittings. This step was taken to simplify the standard and at the same time recognize the manufacturer's desire to eliminate unused items from the list. The lengths of the bolts were revised to agree with current practice and the drilled size of hole for the $1^1/_2$ in. bolt. Provision was made for the spot facing of over-size flanges, and information on drain tappings was also added.

As is generally known, work on the standardization of the 125 and 250 lb cast-iron flange standards was begun as far back as 1894. In that year The American Society of Mechanical Engineers after conferences with the Heating, Piping and Air Conditioning Contractors National Association adopted a standard flange template for the lower pressure which became known as the ASME Standard. In 1901 the Manufacturers' Standard for pressures up to 250 lb came into existence. Then about 1910 the Manufacturers Standardization Society of the Valve and Fittings Industry undertook the task of designing a completely unified line of flanged fittings, including flange dimensions, center-to-face dimensions, and wall thicknesses. The work was completed and published in 1912.

During the years 1912 to 1914, inclusive, a Joint Conference Committee composed of representatives of the MSS and the ASME formulated a group of compromise standard dimensions of pipe flanges and flanged fittings for use under steam service pressures of 125 and 250 psi. The committee's report was completed in the spring of 1914 and was accepted by a conference held in Washington, D. C. which was attended by representatives of the United States Government, the ASME, the MSSVFI, and the HPACCNA. Thus the "American Standard for Pipe Flanges, Fittings, and their Bolting" became effective in 1914.

For further information—address

The American Society of Mechanical Engineers
29 West 39th St., New York 18, N. Y.

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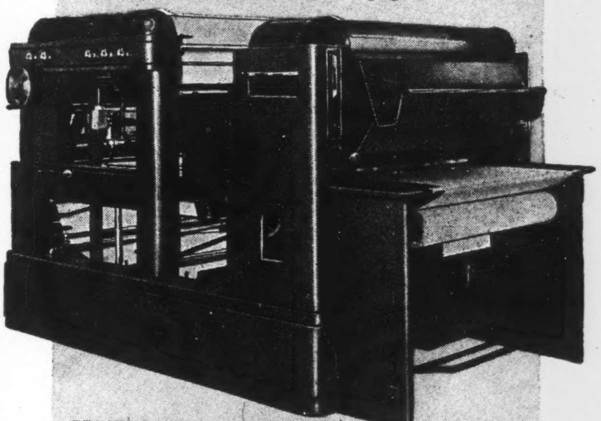

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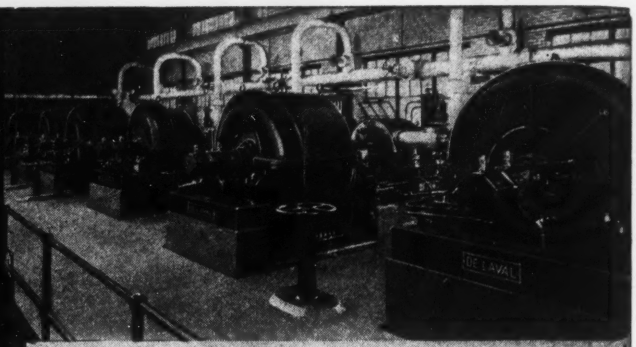
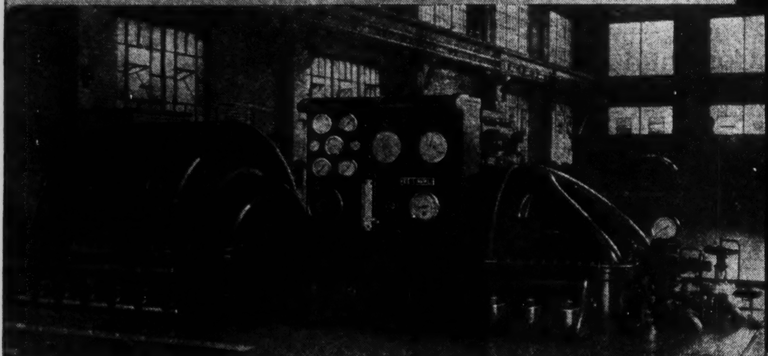


Six De Laval turbine-driven exhausters and boosters in a coke-oven plant. Three are rated at 31,365 c.f.m. each, two at 18,600 c.f.m. each, and one at 25,200 c.f.m.

A 115,000 c.f.m. turbine-driven compressor on test at the De Laval Works.

During recent years numerous repeat orders for De Laval air and gas handling equipment have been entered by large blast furnace plants, by-product coke-oven operators, and domestic gas works. In constructing both the steam power and gas ends of these machines, and also the controls, advantage has been taken of the latest improvements in design and in materials, and their satisfactory operation is testified to by the fact that the users come back to De Laval again as needs expand.

Ask for Catalog F-3824, which contains tables, charts and instructions for the solution of gas handling problems.



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- **mass produced from standard precision parts**
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- **3 models meet entire range of load-travel specifications**
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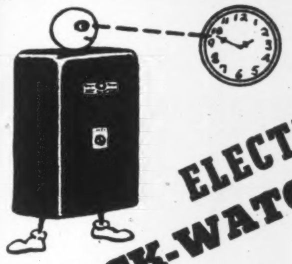

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Limited quantity of high-speed relays (CR7505N100). More than 450 operations a minute. Operate on light-intensity change of ½ foot-candle. Time delay up to ½ second for holding relay closed after light impulse, which may be as short as 0.001 second. Excellent for simple register-control jobs. Automatic seal-in circuit if desired. Relay contacts handle up to 10 amp at 230 volts. Operate on 115 or 230 volts, a-c, 50/60 cycles. Power consumption, 30 watts. Many special features.

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OR TRANSFORMERS? **Now you can test winding insulation right on the production line. New G-E electronic winding-insulation tester simulates severest operating stresses and tests turn-to-turn, coil-to-coil, and coil-to-ground insulation. Reveals shorted turns, wrong number of turns, or incorrect connections. Complete test takes only a few seconds on production line and may save your customers hours of repair work later. Operates on 115-volts, single phase, 60-cycles. Write for more information.**

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—by replacing mechanical contactors with G-E ignitron contactors. No moving parts! No contactor tips to dress. No noise. No open arc. No time lag. Faster production. More exact timing. These electronic contactors use long-life G-E ignitron tubes. One installation paid for itself in four months. More information in Bulletin GEA-3058B.

SIMPLIFY ADJUSTABLE-SPEED DRIVE ELECTRONICALLY

New G-E Thy-mo-trol drive gives you full, stepless speed control on a single dial. Operates from a-c power. No gears, clutches, or belts needed to vary speed. Smooth, shockless acceleration at maximum permissible rate. No current peaks on line. Dynamic braking for quick stops. Holds speed within plus or minus 2 per cent, from no load to full load under full field. Maximum torque at low speeds! It pulls and pulls and pulls. Compact. Easy to install. Motor is the only major moving part. Ask about CR7507. Now supplied in sizes from ⅛ to 15 hp. Special forms and ratings if you need them.

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—WHEN DAYLIGHT DIMS? ***G-E electronic light control turns on lights whenever daylight level is too low—turns them off when daylight is sufficient. Saves eyes, helps maintain production, saves power. Low cost. Bulletin GEA-2679B gives installation information, diagrams.***

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Electronic apparatus for timing, sorting, counting, and controlling is making many wartime jobs easier to learn and easier to do. For example, one manufacturer found that the training period for new riveters was shortened considerably, and results were improved, by using electronic timers to automatically time the riveting hammers. Electronics may be the answer to a similar training problem in your plant. *General Electric Company, Industrial Control Division, Schenectady, N. Y.*

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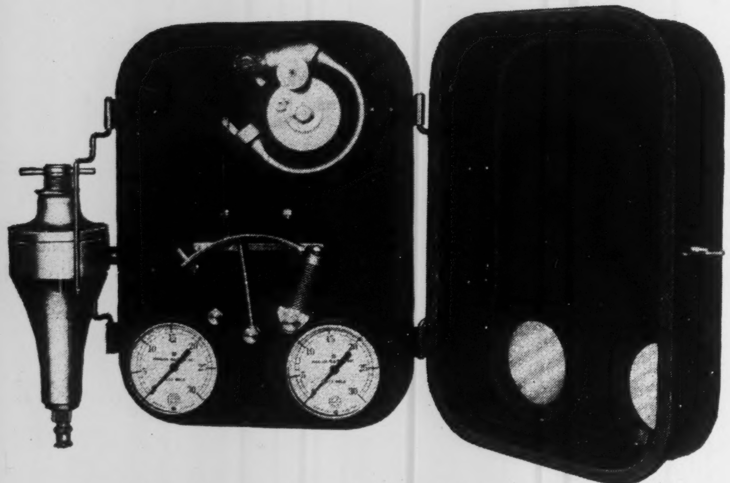
BOURDON TUBE ACTUATED

Ask the men
WHO USE THEM!



Mountable on any H-W Motor Valve Diaphragm Case or for *surface* instrument panel board mounting. Case is weather-proof with wide-swinging door for easy accessibility to instruments for adjustment, repair or replacement of parts. Levers and other working or moving parts are of stainless or plated steel. Bellows of high grade bronze.

H-W Type 1400 Bourdon Tube Actuated Pressure Control Pilot (Non-Recording) is designed to operate as a Vacuum or Pressure Control Pilot for pressures from vacuum to 5,000 lbs. The Type 1400 Pilot has a wide *Throttling Range* adjustment of from 0% to 200%. Thus, this Pilot is universally adaptable for services requiring extremely high sensitivity or for service conditions where wider *Throttling Ranges* are necessary to *dampen* the sensitivity. Wide throttling range overcomes *cyclic* or *hunting* action caused by *over-sized* control valves or other conditions existing in the system making *lined-out* pressure control difficult.

The H-W Type 1400 Pressure Pilot assures performance matching other H-W Control Equipment used throughout the Refining, Chemical, Synthetic, Gasoline, Recycling and Power Industries and is adaptable for:

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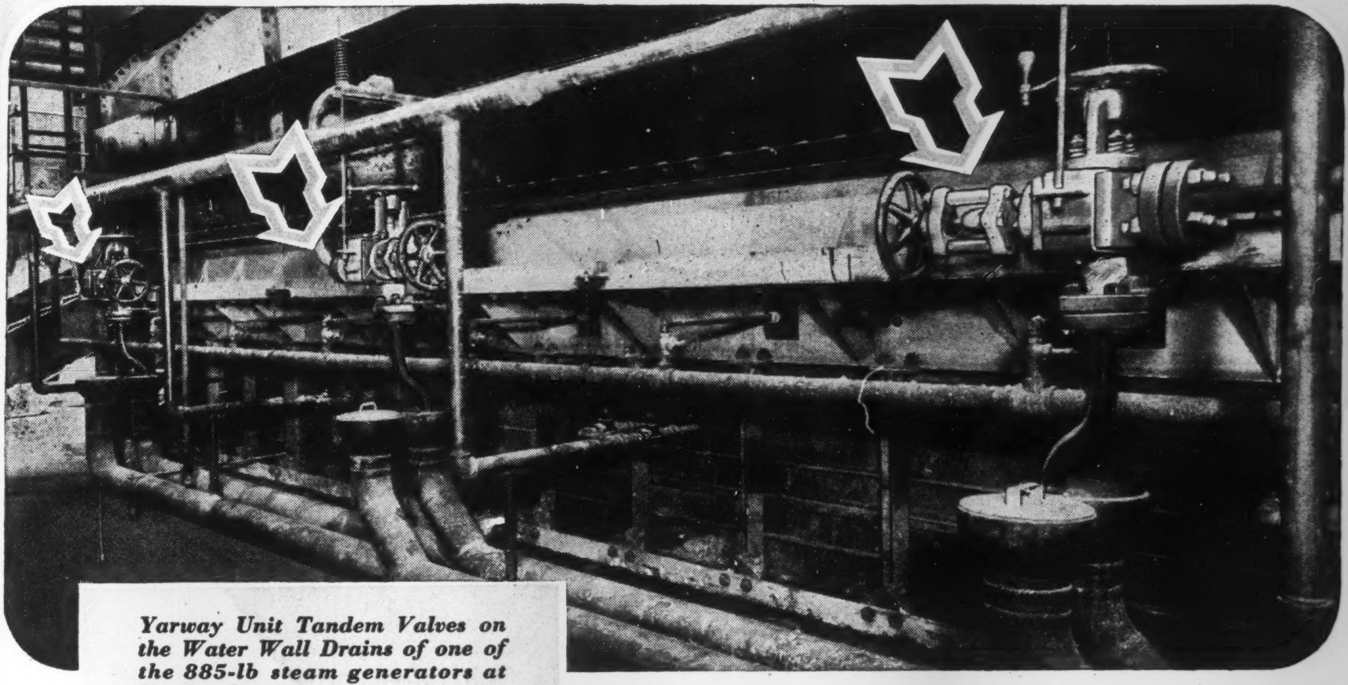
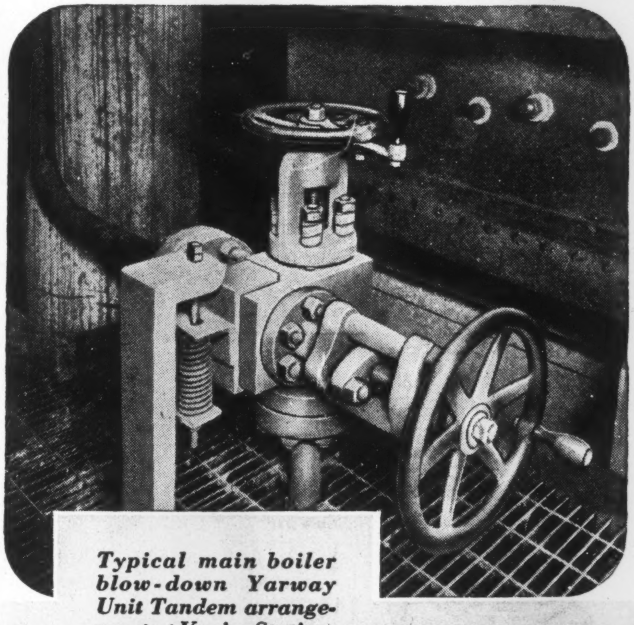
Selected for Both Blowing and Draining on latest VENICE STATION units



Yarway Unit Tandem Valves on the Water Wall Drains of one of the 885-lb steam generators at Venice Station.



Typical main boiler blow-down Yarway Unit Tandem arrangement at Venice Station.

AT the new Venice, Illinois, Station of the Union Electric Company, Yarway Unit Tandem Blow-off Valves were selected for both main boiler blow-down lines and water wall drains on these latest 885-lb pressure units.

Years of experience with Yarway Valves at the Cahokia Station of this company where 240 Yarway Seatless Valves have been on the job—some as long as 14 years—undoubtedly played a big part in influencing the selection of these Unit Tandems—the finest Yarway Valves ever built for high pressure service—for this modern central station.

What are your drain or blow-down valve requirements? Profit from the sound design and metallurgy of Yarway Valves, proved in more than 12,000 low, medium and high pressure Yarway installations.

Write for Catalog B-422 for pressures up to 400 lb; B-431 for pressures up to 2500 lb.

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108 Mermaid Avenue, Phila. 18, Pa.

YARWAY BLOW-OFF VALVES

ARE YOU HOARDING IDEAS?

Are you storing away in the back of your head—in safe or desk drawer—the plan for a mechanical or electrical device that you mean to bring out *after the war*? Wars always end more abruptly than they begin. How long would it take you, if the war should end next month, next year, or even two years hence, to get that product into distribution? Bring your product to us NOW! While General Instrument is at present engaged 100% in war effort, our plants and personnel are geared for the development and volume output of precision products—all set to swing into civilian service the moment the Axis runs up the white flag.

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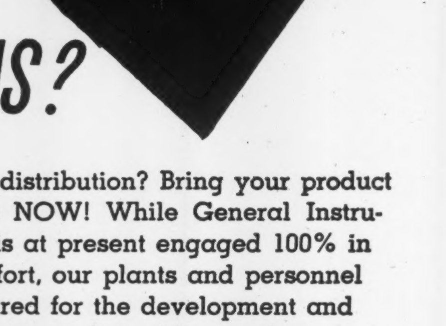

At a time when a global struggle for freedom was not even dreamed of, General Instrument was engaged in wide-scale development of peace time products like this for peace time use.

GAZE ON A MIRACLE IN *Gear Production*

BOMBERS carrying bigger loads than freight cars! Fighters that can dive faster than sound travels! These are modern miracles of air warfare—miracles made possible by the giant Wasp Engines that power these planes.

And miracles beget miracles. For in these engines are gears of such extreme precision that their manufacture by any other method save exhausting hand labor, was long deemed impossible. Transforming these hand methods into mass production—turning out these high-precision gears by the hundreds of thousands needed for the world's largest air armada—was an achievement made possible by new manufacturing methods—new production techniques developed by Foote Bros.

These precision gears may well open the way to new miracles in the economical transmission of power when the war is won. For already on the boards of many American manufacturers are plans for machines that will utilize the type of precision gear Foote Bros. are producing for aircraft engines.

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Better Power Transmission Through Better Gears

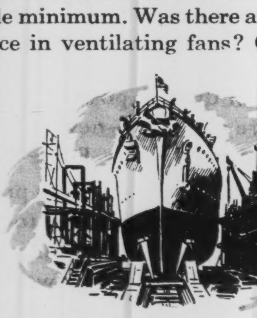
The Story of a SECRET AIR

...Now on The U.S.S. Helena 40 Fathoms Down—In Kula Gulf!

PERHAPS YOU'VE HAD WIND of this story already. It's being talked about in engineering circles, among production men, even executives. Make no mistake — when a development comes along, so different that the U. S. Navy takes it over — lock, stock and barrel, that's big news — and has implications for all business and industry.

For its beginning let's go back to before Pearl Harbor. America's fighting fleet was being designed along lines that packed more power and more armament, ship-for-ship, than anything else afloat. Space for ammunition and men had to be shrunk to the irreducible minimum. Was there any chance of saving weight and space in ventilating fans? Could the compactness of an axial flow fan be combined with the performance of a centrifugal fan? From existing knowledge of fan performance it seemed impossible. But, since one battleship needs as many as 300 separate ventilating systems, an attempt must be made.

1940—MORE SPEED AND ARMOR MEANS LESS SPACE FOR AUXILIARIES



Here was a job for the best engineering brains in the country. The U. S. Navy Bureau of Ships wrote the toughest specifications they could devise — and then subsidized two separate research authorities to develop a fan to meet them. One was the country's outstanding industrial research laboratory — the other, one of the nation's foremost experts on aerodynamics. The results turned in were good, but not good enough. The fans did not deliver the volume and pressure required — and were above the acceptable noise level.

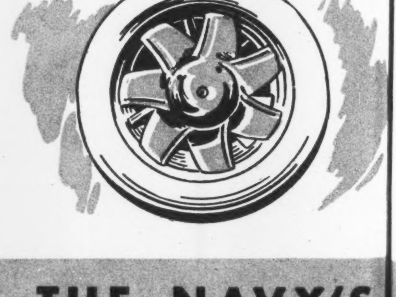
Time was slipping away and, for the United States, war was just over the horizon. Then the Navy came to Sturtevant and put the job up to us.

1941—THE NAVY ASKS THE IMPOSSIBLE—FINDS IT READY AND WAITING

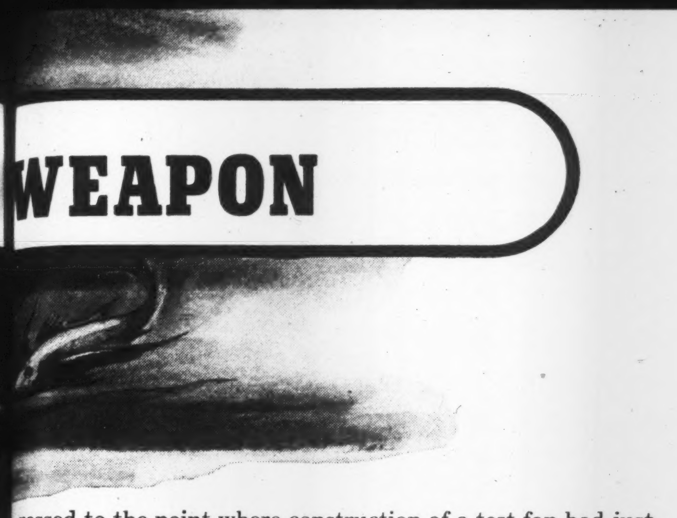
Here were the requirements — a fan to deliver 12,000 cubic feet a minute (50% more than they had been working toward before) at 3″ pressure and a speed of 1160 rpm. It would be ideal, of course, if it could operate at 1750 rpm because weight of the motor and size of the fan could be cut still further.

Now, as luck would have it, the Sturtevant Research Laboratory had been examining a new theory of designing propeller fans. When the Navy came to us, work had prog-

THE FAN THAT CAUSED ALL THE SHOUTING ABOUT AXIAL FLOW



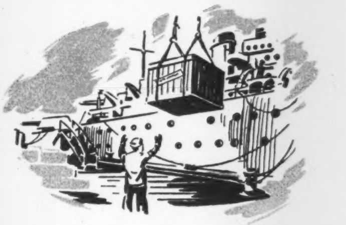
STURTEVANT — ORIGINATOR OF THE NAVY'S



R WEAPON

ressed to the point where construction of a test fan had just been completed. Although no experimental work had been done on the fan, we brought it out for inspection. At first glance it appeared to be exactly the fan the Navy men had dreamed of. On the test block it delivered 12,000 cfm at 3″ pressure — on the nose! And at 1750 rpm it showed a sound energy that was 40% under the Navy maximum! Performance astounded them — total efficiency 90%; static efficiency over 80% — better than anything ever achieved with centrifugal fans.

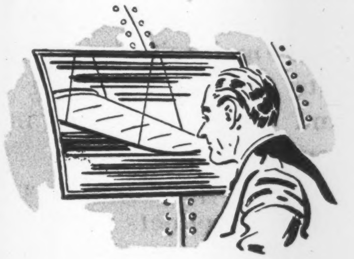
SENT TO SEA WHEN ONLY FOUR WEEKS OLD



Next came a trial run at sea. Less than four weeks after the test fan had been built, it was aboard the U. S. S. HELENA. Line officers were as enthusiastic about the lack of noise as the engineers had been about its performance. Success of the Sturtevant Victory Axiflo Fan, as it is now called, was written in the initial order for 280 units. Today, that original Axiflo Fan — the first, hand-built unit to embody this great step forward in air engineering, shares with the HELENA its hallowed grave in the waters of Kula Gulf.

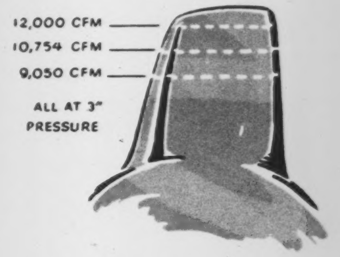
But let's return to the laboratory, for a minute with Harold F. Hagen, our Chief of Research. Here was a development that went right from the sketch pad, into the drawing room and the shop *without experimental development* — and then into large-scale production. How was this possible? Principally because it had been completely proved in theory, before any experiments were made. The new theory conceived by Mr. Hagen was based on the tests of airfoils in a wind tunnel. In putting this theory through its paces, however, he found that these tests could not be applied directly to a fan propeller. In the case of a plane, the air stream is changed only slightly whereas with a fan it is definitely curved. So he dropped the straight line of the airplane flow and substituted the curved line to get proper action of the fan blade — and then applied the airplane theory to that curved line.

THE AIRFOIL TESTS APPLIED TO A PROPELLER FAN



As the design progressed, the blade angles and area of blade surface proved to be just about equal to empirical designs. The result was a blade that does an equal amount of work throughout its entire surface — whether at the hub, the middle or the tip. Air delivery of a specific fan, for example, with blade lengths varied all the way from 46″ to 26″ was always at 3″ pressure — with a volume proportional to the length of the blades. Among the orders for the first 1,500 Axiflo Fans, there were 66 different sizes. These were completely covered with 8 standard fans — simply by changing the blade lengths.

THE RESULT OF A COMPLETELY THEORETICAL DESIGN



With the outbreak of war, Navy demands for Victory Axiflo Fans skyrocketed. Today, thousands of Sturtevant Victory Axiflo Fans are in service aboard battleships, cruisers, aircraft carriers, destroyers, subchasers — in fact, every type of naval vessel. But even Sturtevant's great shops were unable to fill the demand. Other manufacturers were impressed by the extraordinary success of the new type of fan and followed Sturtevant's lead. Two were successful, and are now supplying excellent fans of their own.

The Victory Axiflo Fan belongs to all America. It belongs to the men of the Navy who serve with it now and to the men of industry who are waiting to use it after Victory — to open new fields of heating, ventilating, air conditioning, mechanical draft and other applications where fans are used.

B. F. STURTEVANT COMPANY
Hyde Park **Boston 36, Mass.**

THE ANSWER TO YOUR WHYS AND HOWS— FREE ON REQUEST ➡

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Victory
AXIFLO FANS

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Sturtevant
REG. U. S. PAT. OFF
Puts Air to Work

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Shadow
OF THINGS
TO COME
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WELDMENTS
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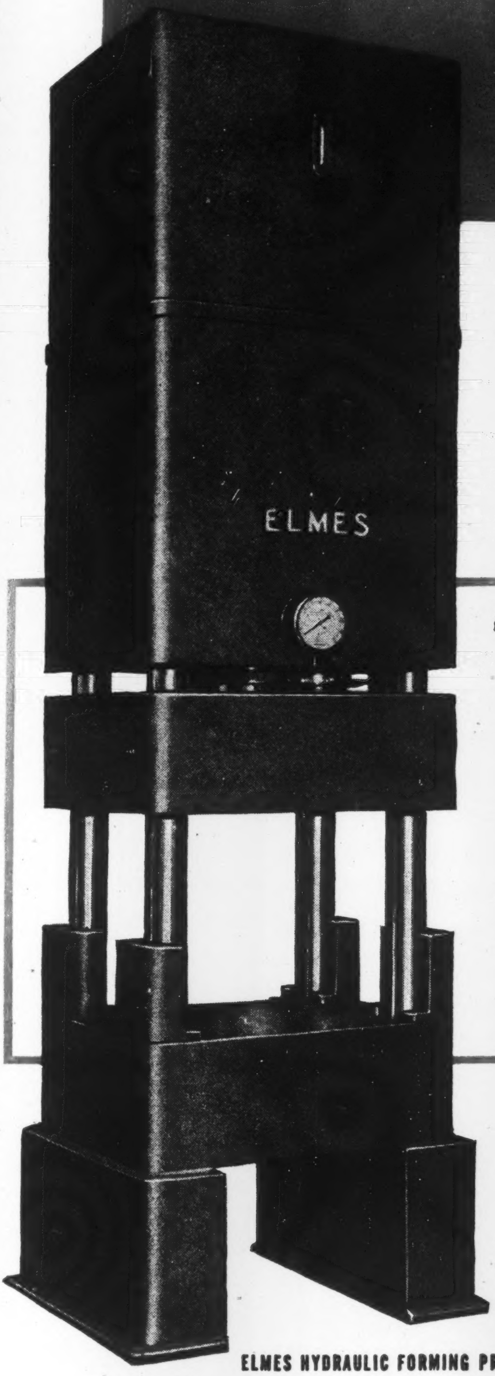

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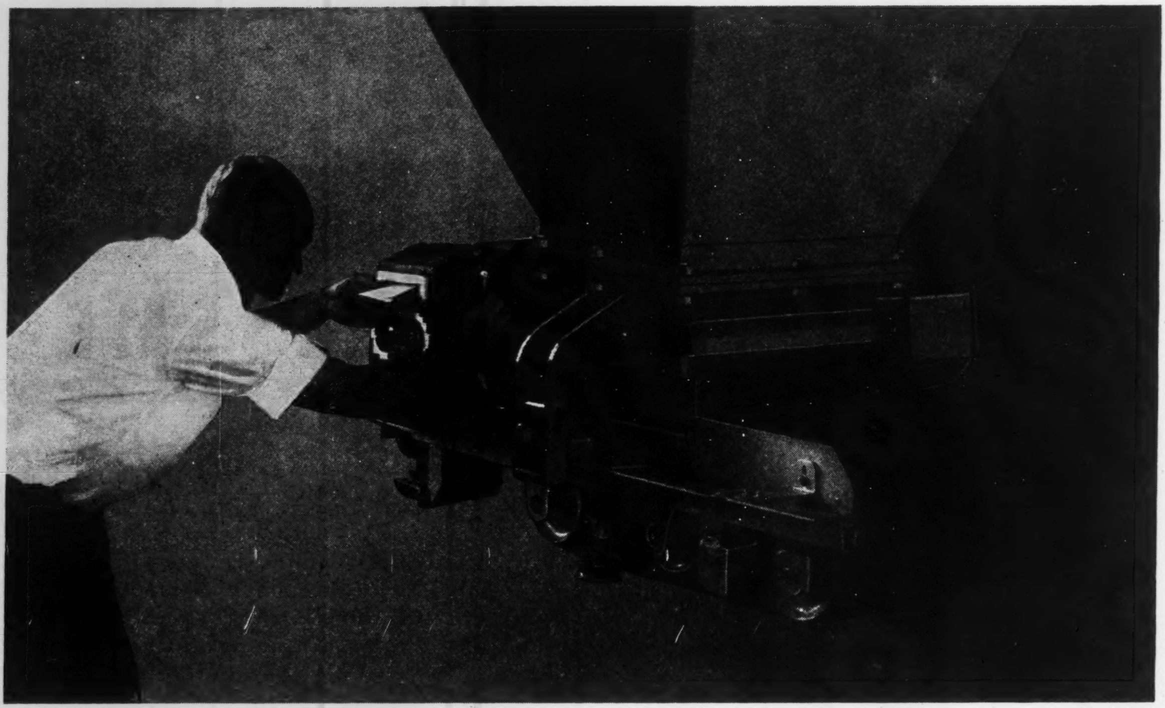

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When equipped with the no-load cut-off attachment, a signal light or bell indicates an empty bin or material hanging in bin and stops the feeder.

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The "Feedometer," a weight and rate indicating feeder, indicates the rate of feed and totalizes the amount fed. This feeder operates on the constant weight principle.

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- Limestone
- Pigment
- Salt
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- Soda Ash
- Sodium Silicate
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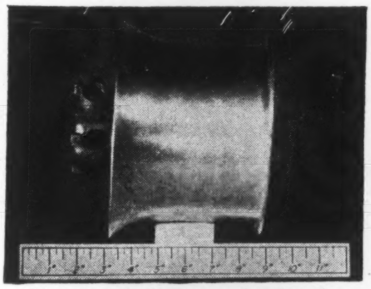
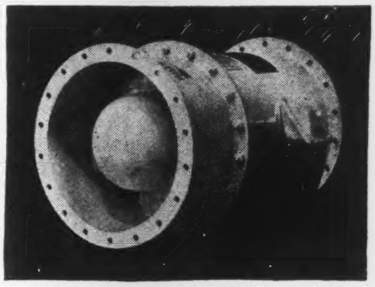
LA-DEL
AXIAL-FLOW
AIR FANS

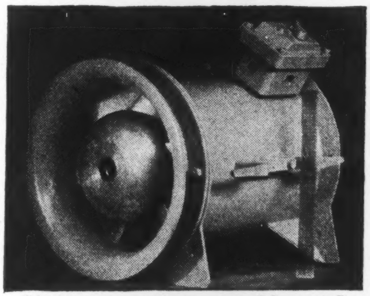
–a name assuring many advantages for post-war developments in the movement of air



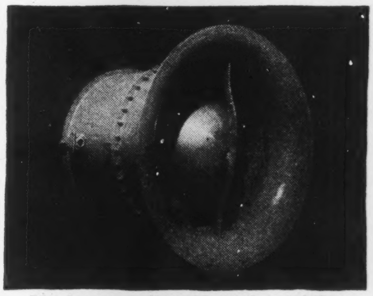
Compact Aviation type axial-flow fan only 6½" in diameter x 6" long delivering 400 CFM at 6" static pressure.



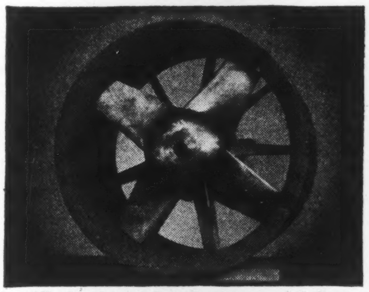
Marine type axial-flow fan 15½" in diameter; delivering 2000 CFM at 3" static pressure.



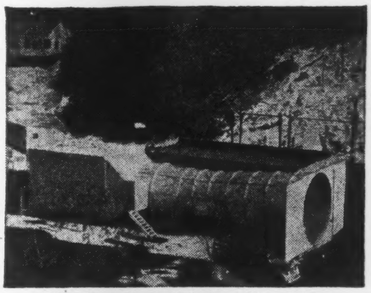
Marine type explosion proof fan 10½" in diameter delivering 500 CFM at 2½" static pressure.



Marine type adjustable pitch axial-flow fan with flared intake.



All aluminum Aviation type axial-flow fan. 70 lbs. complete with 2½ HP motor; 4300 CFM at 2" static pressure.



11 ft. diameter axial-flow fan with exhaust stack and air shaft hood delivering 500,000 CFM at 6½" static pressure.

HERE are a few of the developed sizes of La-Del Troller Axial-Flow Fans. Wartime conditions have prevented offering La-Del Axial-Flow Fans to industry in general, because of war agencies' demand for compact units of this kind.

A wide variety of models at present are available ranging from ⅛ HP to 1000 HP; from ¼" static pressure to 45" static pressure; from 6" in diameter to 11 feet in diameter; and, from 400 CFM to as much as 600,000 CFM.

Post-war La-Del requirements will probably bring about the development of many additional sizes to meet industry's requirements, since present application of Axial-Flow Fans has firmly established the many desirable design features of this type fan.

Many models are available with either fixed pitch blades or adjustable pitch or controllable pitch, making available fan operating ranges never before realized. Control of operation and air delivery is accordingly more closely regulated with the numerous advantages resulting from this in many applications.

ARMY E NAVY

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TO SPEED VICTORY

LA-DEL CONVEYOR & MANUFACTURING CO.
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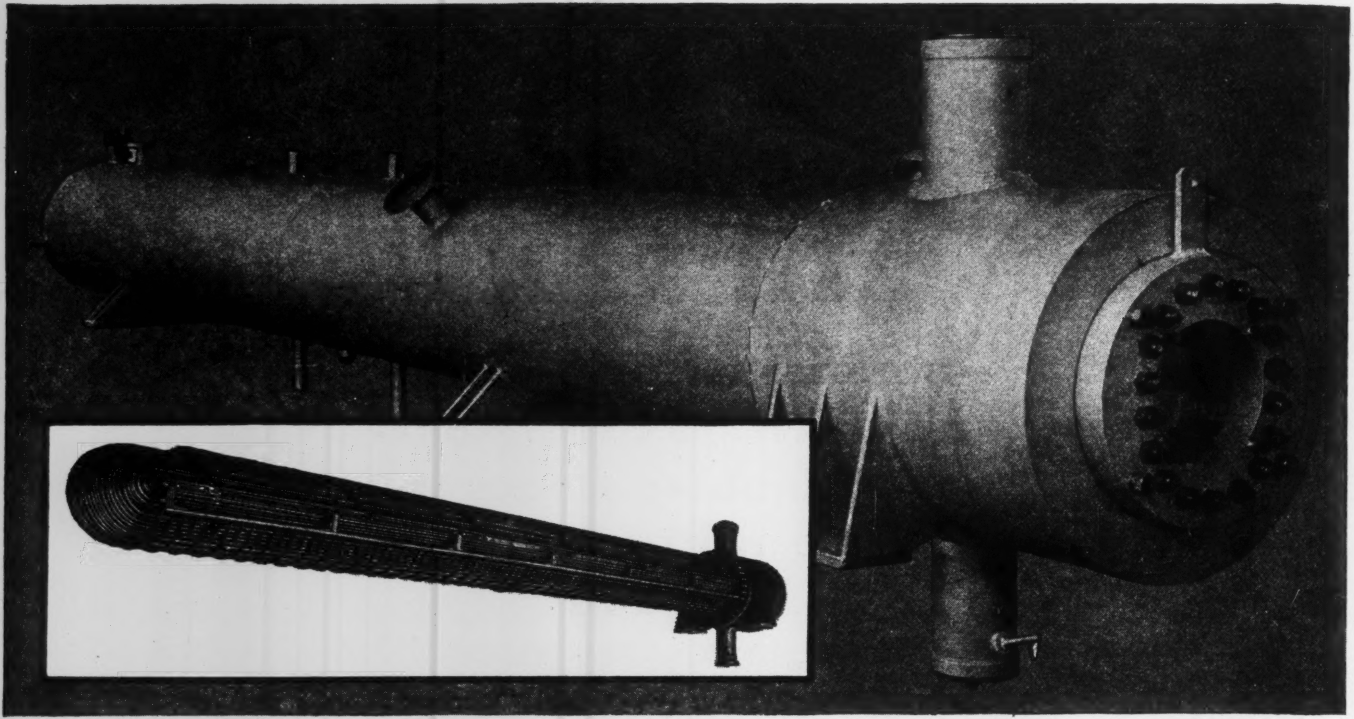
ENGINEERS OF LA-DEL AIR MOVEMENT

★ **PIONEERS IN THE DESIGN OF AXIAL-FLOW FANS FOR EFFICIENT AIR CIRCULATION** ★



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SIMPLICITY... because the U-tube construction and tube sheet integral with water head requires a minimum of high pressure joints.

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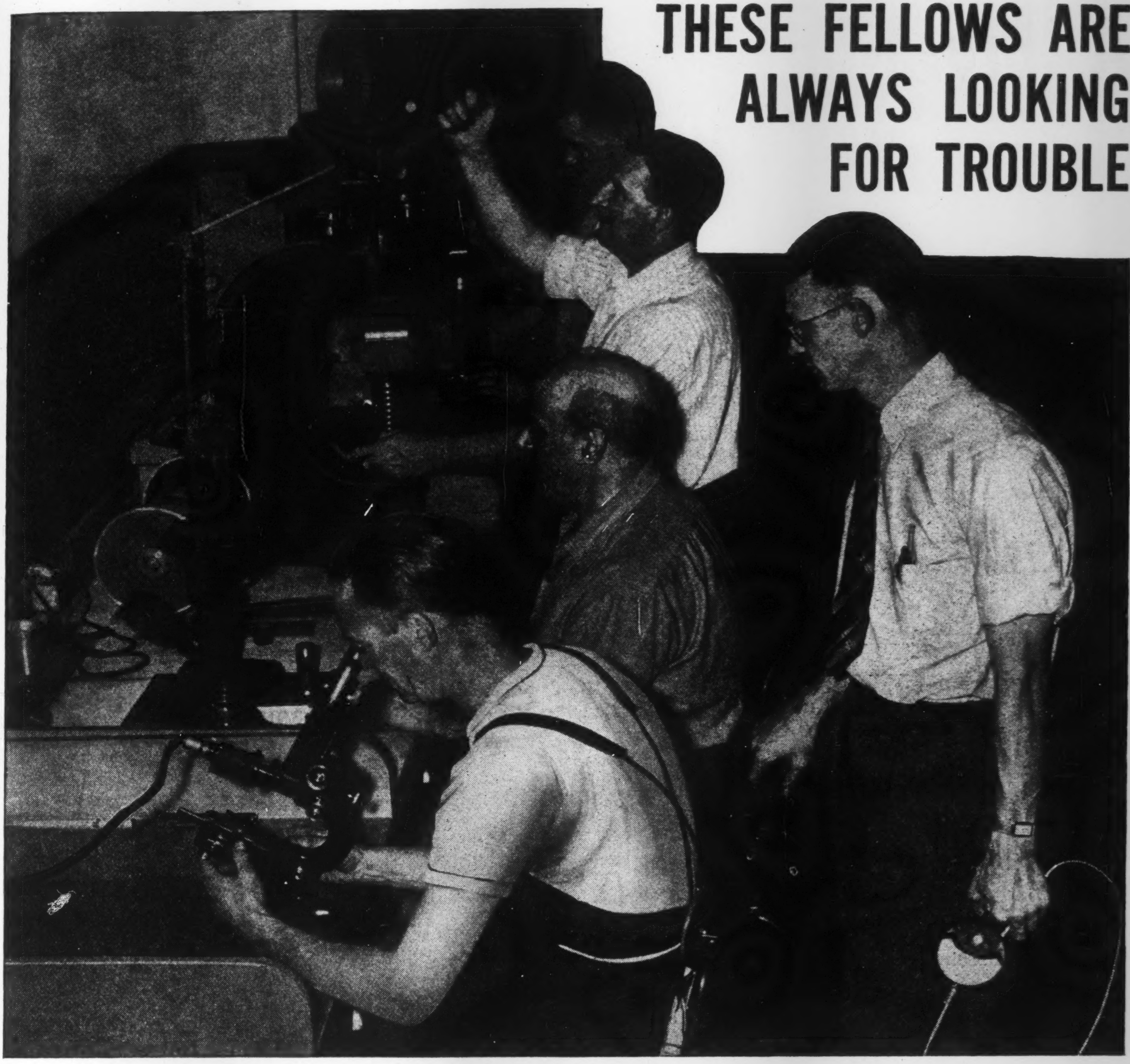

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—so they can prevent it! They're the "watch dogs" of our Heat Treating Processes, where good bearings get off to a good start. Theirs is a roving commission, *re*-checking the checking done by the regular inspectors—to make doubly sure each step of the Heat Treatment of Hyatt Roller Bearings produces perfect results.

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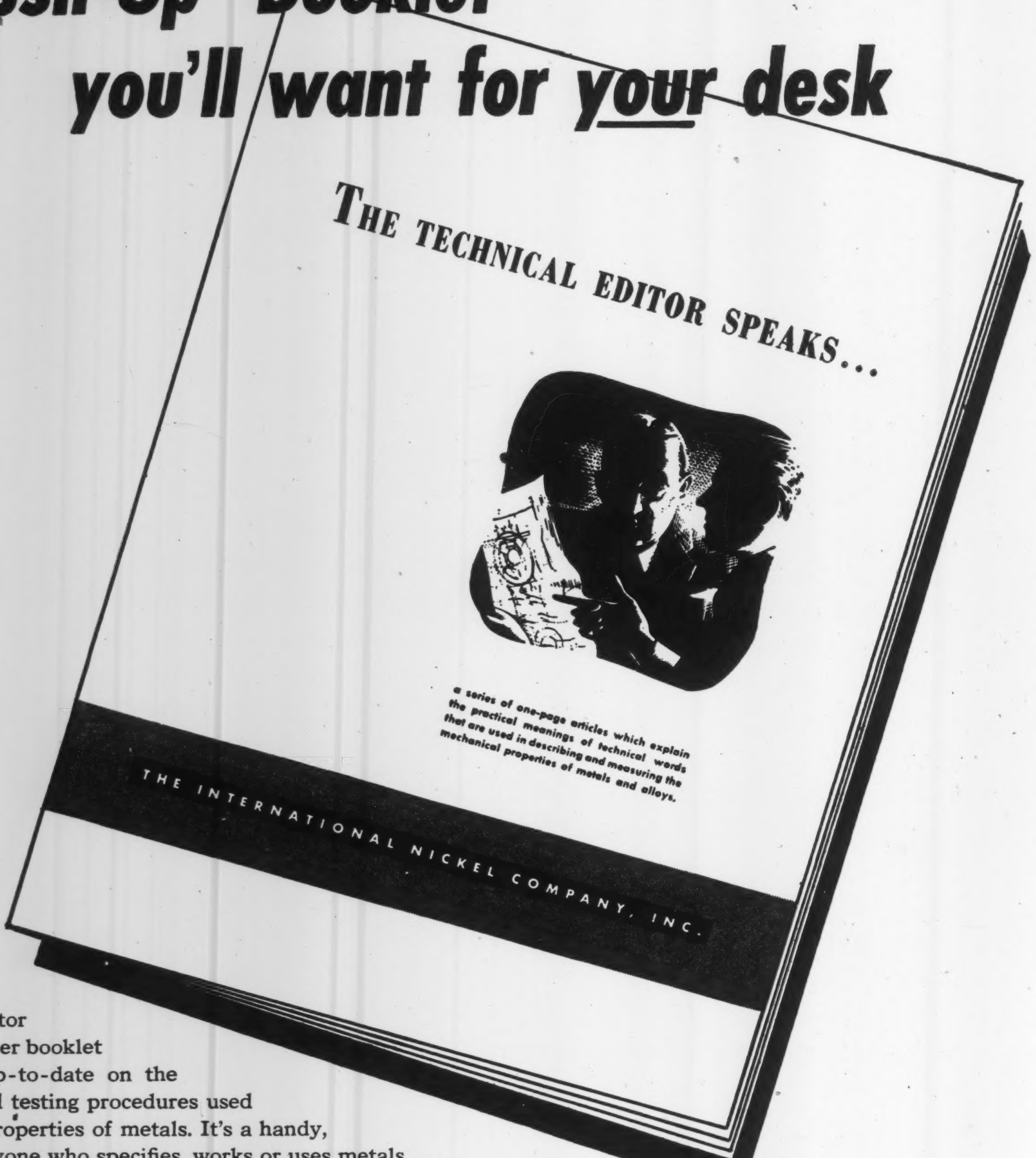
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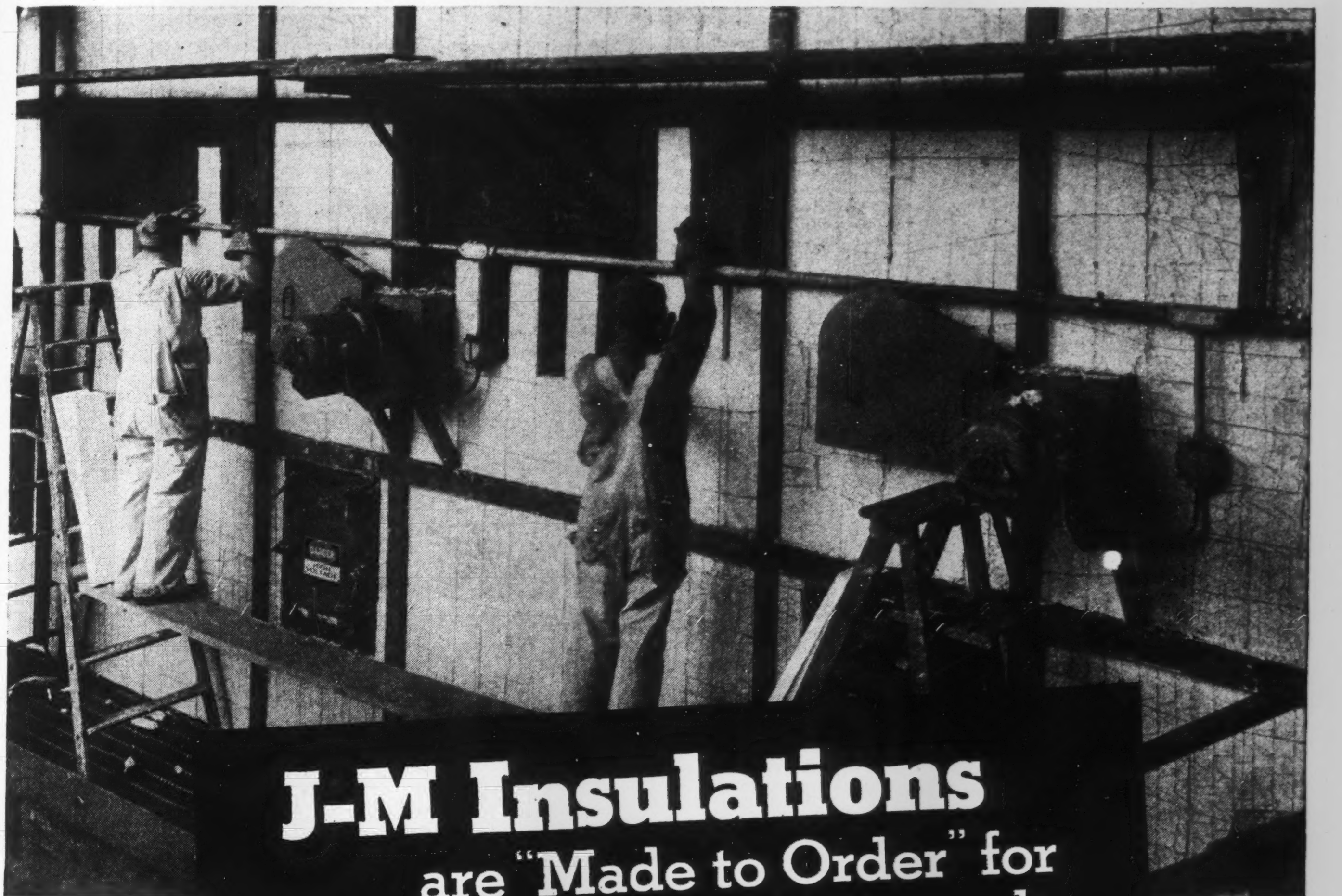

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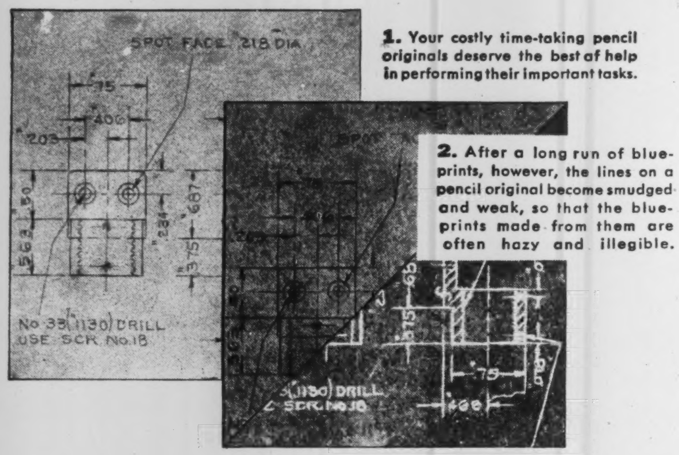

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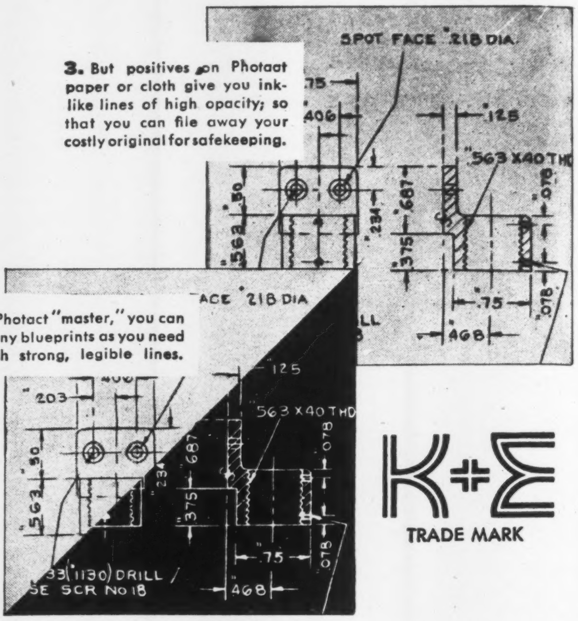

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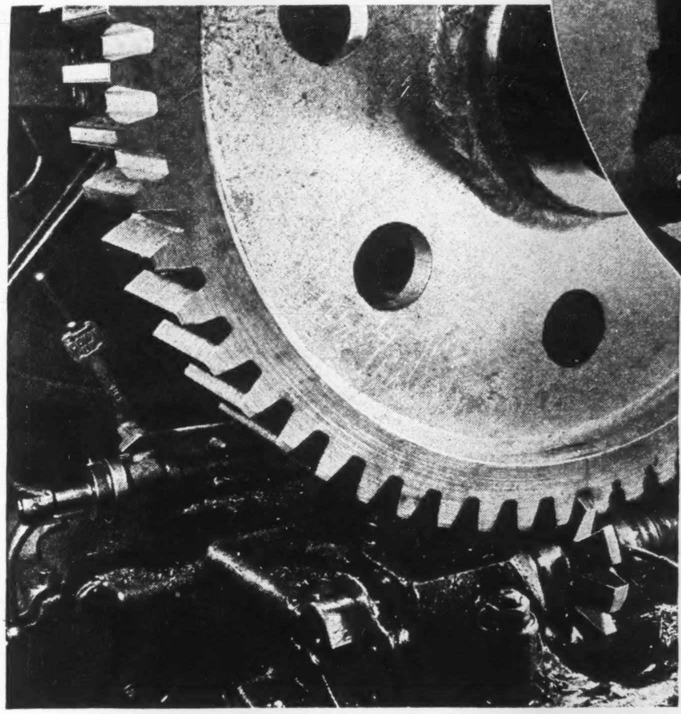

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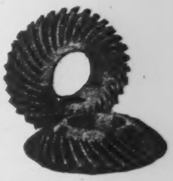

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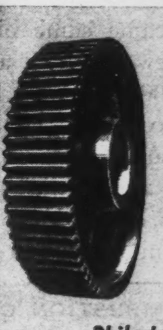

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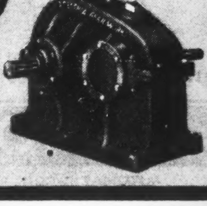

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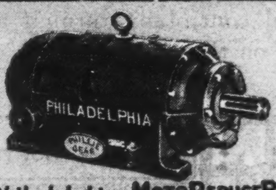

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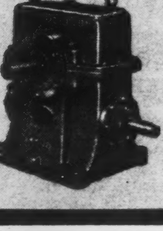

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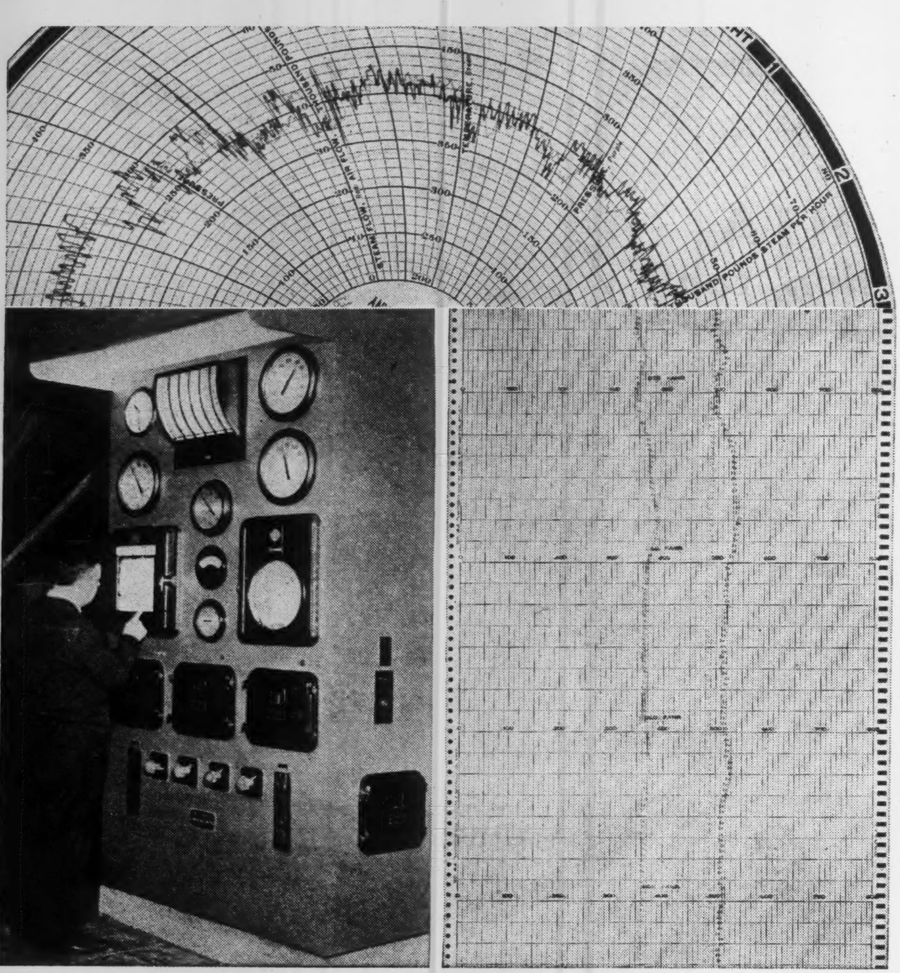
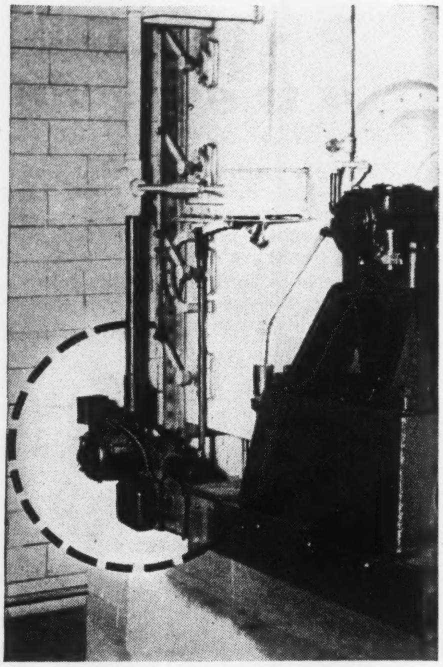
A Slogan For Every American



Top—Bleeding of turbines for process steam causes the swings shown on Utica Knitting Co.'s stoker-fired boilers. *Left*—Boiler Panel with Metermax Combustion Control and Micromax Temperature Recorder. *Right*—Typical section of Micromax Chart.



Metermax-controlled Electric Drive Unit on inlet vanes of forced-draft fan.

HIGH BOILER EFFICIENCY?

Utica Knitting Co. Gets It With Metermax Combustion Control

Faced a few years ago with heavier demand for its products, the big Utica (N. Y.) Knitting Co. translated that demand into steam, took a careful look at its steam plant, and decided to install more capacity—at once. Out came some old boilers, up went a new building, and into it went a 50,000 lb/hr C. E. stoker-fired boiler, to supply 225 lb steam at 100 degrees superheat.

Prominent among the problems to be solved was, of course, how to operate this big unit? How to give U. K. Co.'s firemen the kind of help they would need with a boiler so totally different from the ones they were used to? How to operate this unit in parallel with their remaining older and much smaller boilers?

The answer is in the pictures herewith. Metermax Combustion Control has the flexibility that boiler operators need; any adjustment can be changed at any time; the unit can be returned partly or entirely to manual control by turning a single switch on the boiler panel.

And Metermax has the sensitivity needed for efficiency; the full sensitivity required for powdered-coal boilers in central stations is built into every Metermax.

Furthermore, Metermax is simple; its controllers are pneumatic-electric; and its drive units are entirely electric. No line shafting; no hydraulic or pneumatic lines; no connection between panel and drive unit except a single conduit run.

The Metermax Panel reaches you complete, ready for outside connection to fans, feeders, etc. We will if you wish assemble and mount all gauges, indicators and other accessories. We do excellent work of this kind!

If you have a boiler-control problem, outline it and an L&N engineer will gladly try to help. Or if a compact, fully-illustrated catalog will meet your needs, ask for N-01M-163.

Jrl Ad N-01M-163(1)

TYPE P COMBUSTION CONTROL; COMPANION TO METERMAX

If your plant does not require the central-station characteristics of Metermax Combustion Control, we recommend Type P Control. It is simple, sensitive and thoroughly dependable. Ask for Catalog N-01P-163.

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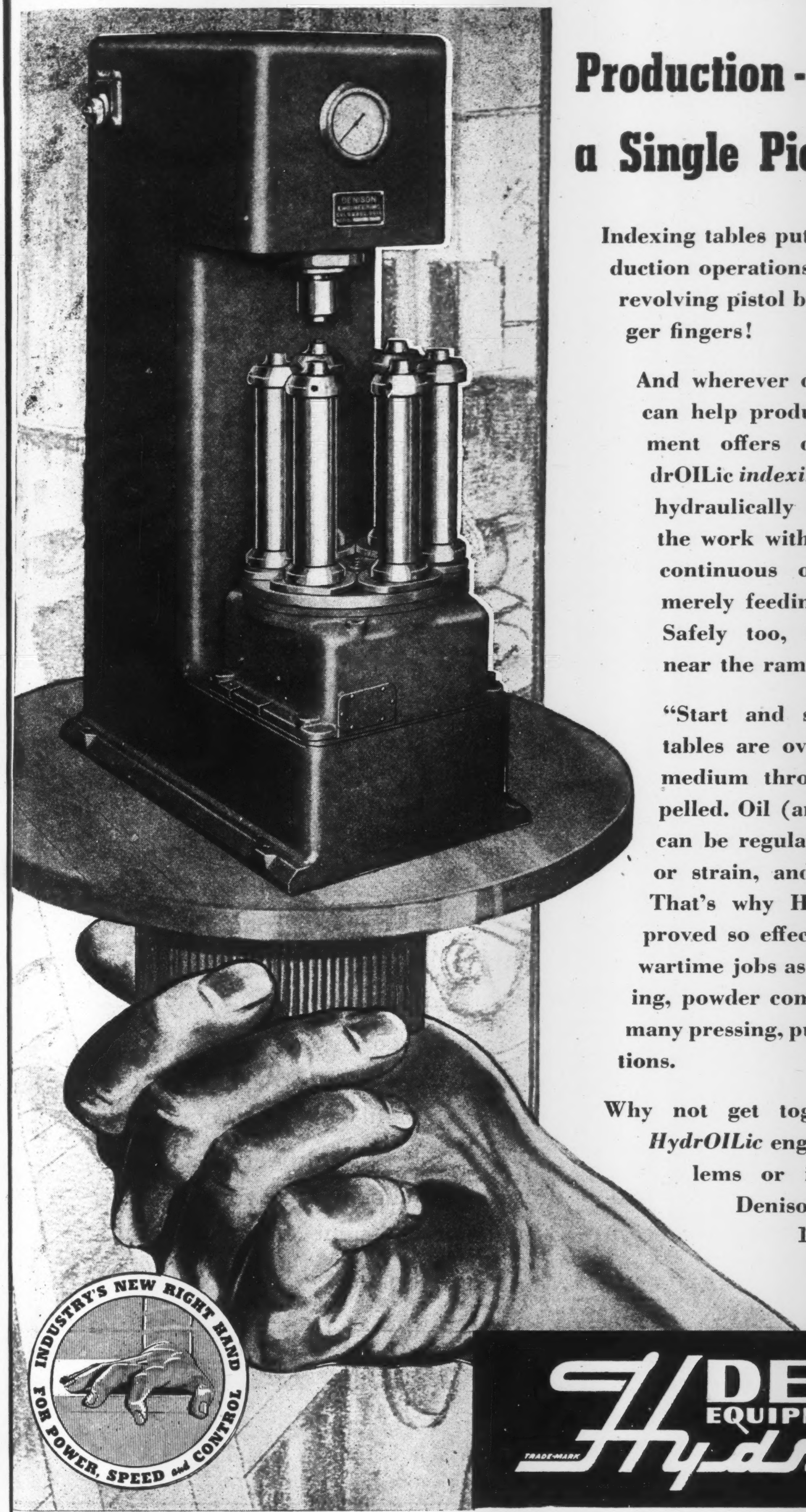
Indexing tables put wings on many production operations—as effectively as the revolving pistol barrel put wings on trigger fingers!

And wherever quick, accurate indexing can help production, HydrOILic equipment offers distinct advantages. HydrOILic *indexing presses* show why. Their hydraulically operated tables position the work with higher precision. Rapid, continuous operation is achieved by merely feeding and emptying the table. Safely too, because hands are never near the ram.

"Start and stop" shocks of indexing tables are overcome, because *oil* is the medium through which they are propelled. Oil (and the speed of the tables) can be regulated instantly without wear or strain, and with absolute accuracy. That's why HydrOILic equipment has proved so effective in speeding up such wartime jobs as shell loading and crimping, powder compressing . . . as well as many pressing, pushing and lifting operations.

Why not get together with Denison *HydrOILic* engineers on your problems or ideas? Write. The
Denison Engineering Co.,
1189 Dublin Rd.,
Columbus, Ohio



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WHILE age alone provides no claim for preferential consideration, our 33 years in this industry have given us exceptional experience in permanent magnet applications. This experience should prove invaluable to you in the solving of your engineering and development problems.

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Write on your letterhead, for the address of our office nearest you—and our 30-page "Permanent Magnet Manual".

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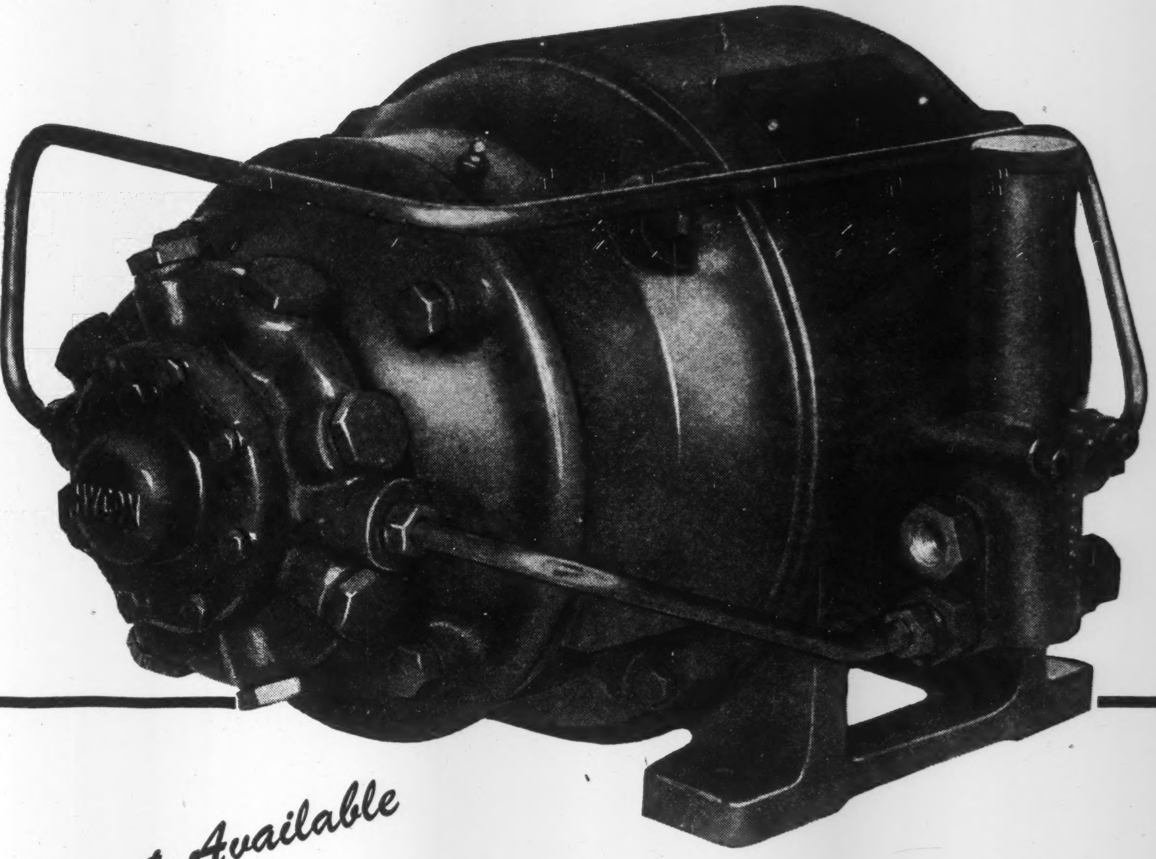

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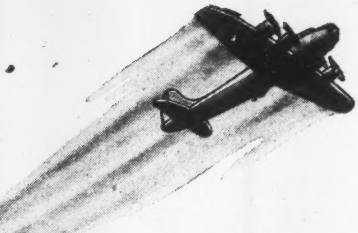

CHAIN *too, has reached new ceilings!*

● Flying and fighting seven miles up, the modern war plane, capturing our fascinated wonder, is the symbol and the result of vast developments in every sphere of science and industry. In that plane, as in the plant that built it, and throughout industry today, power is produced, applied and controlled more efficiently because of continuing and accelerated engineering progress.

Chains used today for aircraft controls, for tanks, trucks, jeeps and other motive equipment, for conveying and mechanical power transmission throughout industry, have been vastly improved to meet today's exacting demands. Link-Belt engineers and metallurgists have perfected lighter, stronger, more precisely built chains of every type, answering, even anticipating, the needs of our production and fighting forces. Now, more than ever, Link-Belt is the recognized source for chain, and for the engineering service to aid in utilizing these newer, better chains to the great advantage of all industry.

Consult Link-Belt on any problem relating to mechanical power transmission, materials handling or conveying. You are assured of reliable, unbiased recommendations and of efficient, economical equipment.

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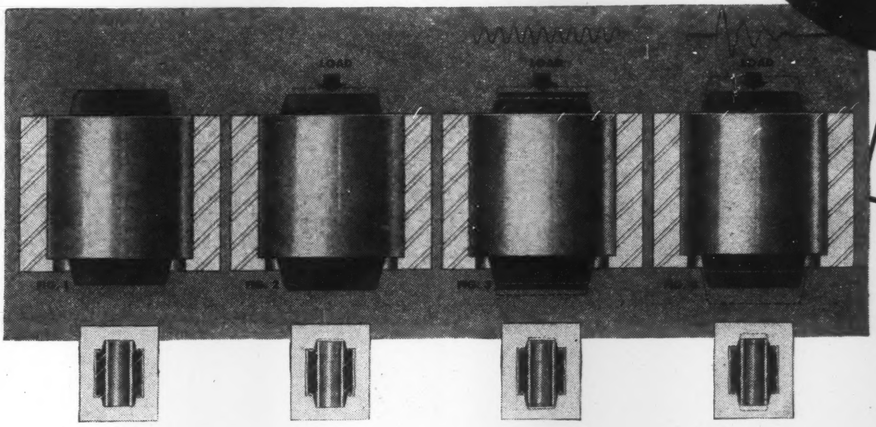
PRECISE LOAD RATINGS

SIMPLICITY OF APPLICATION

LORD
BONDED RUBBER
Shear Type
MOUNTINGS

PROVIDE THE ULTIMATE IN VIBRATION CONTROL



OPERATION OF TUBE FORM MOUNTINGS

ALL Lord Mountings are designed to operate on the principle of having the rubber "stressed in shear" when load is applied in the direction of the main axis of the mounting. This design provides the required softness and deflection in the direction of the disturbing forces, and stability or resistance to movement in directions normal to the major thrusts.

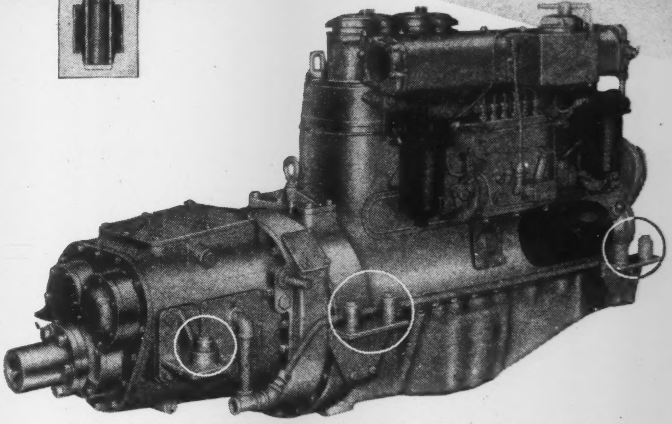
Every Lord Mounting is designed to have a definite static deflection under its rated load. Load ratings for standard tube form mountings range from a few pounds to 1450 pounds, with rated deflections ranging from .065 inches to .123 inches when load is imposed.

Illustrations above show a Lord Tube Form Mounting in the various positions it assumes while static or in action.

- Fig. 1—Under no load (as produced). Note position of center sleeve.
- Fig. 2—Under rated load; note deflection of center sleeve.
- Fig. 3—Operating in the zone of free shear action under normal vibration.
- Fig. 4—Operating momentarily under sudden shock load or in zone of resonance.

Load ratings of Tube Form Mountings may be changed by:

1—Utilizing rubber compounds of varying degrees of stiffness.
2—Increasing length and/or cross-section of rubber element and metal parts.
3—Increasing or decreasing diameter of center metal sleeve.


Kermath Marine Engine suspended on Lord Tube Form Mountings

These design features, plus the unified control of manufacture from raw material to finished product, account for the remarkable efficiency and dependability of Lord Mountings.

Lord Tube Form Mountings are sturdy, compact, light weight units, and are designed to cover a wide range of applications in every field of industry. They are made in various styles and many sizes with flanged or straight outer metal members, and with snubbing or non-snubbing features.

Through proper mounting selection, isolation efficiencies ranging from 75% to 85% reduction of disturbing forces may be expected, although reductions up to 97% are not unusual on equipment operating at very high frequency.

For complete information on Lord Mountings write for bulletins 103 and 104 or call in a Lord vibration engineer for consultation on your design problems. There is no obligation.

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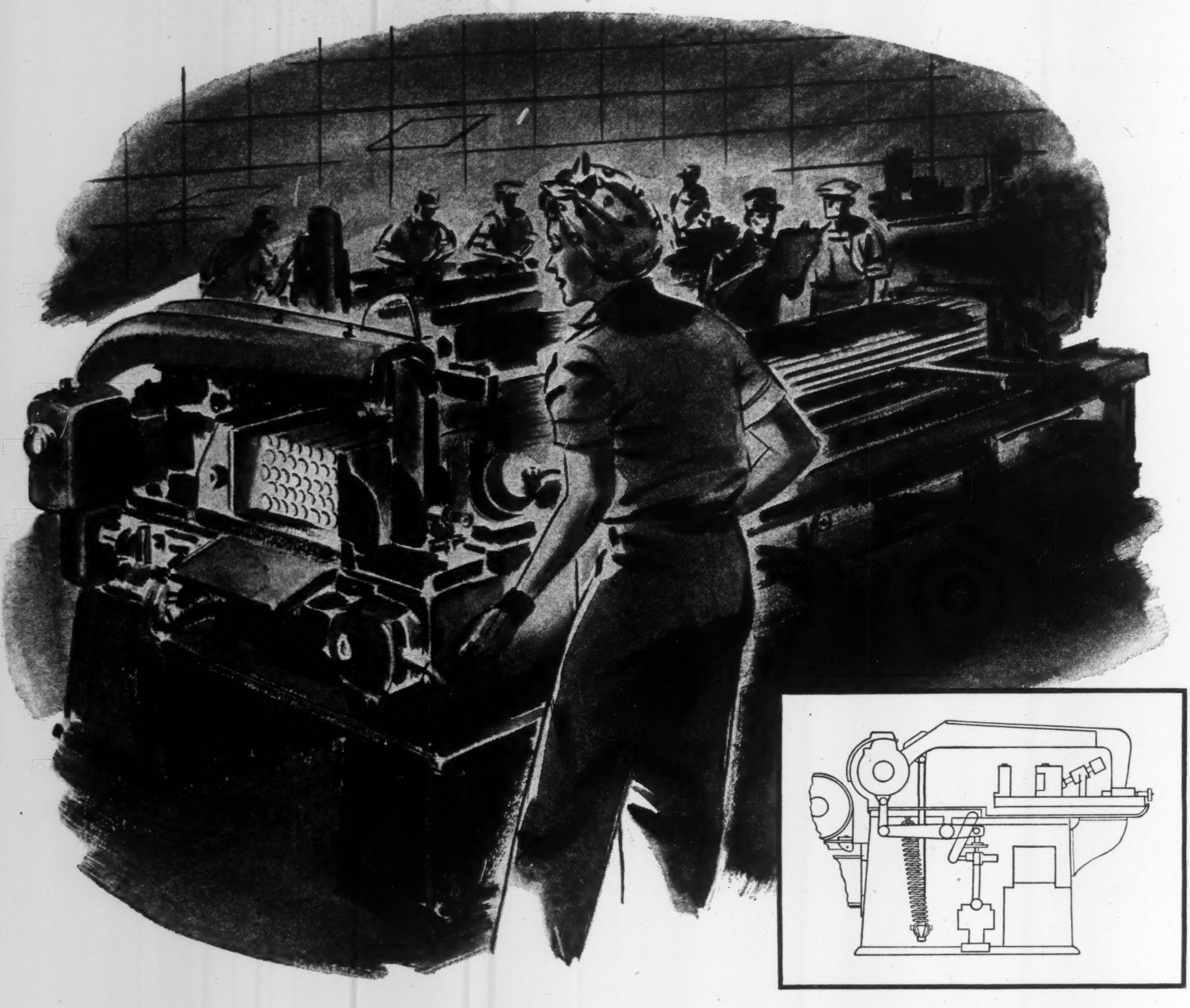
Originators of Shear Type Bonded Rubber Mountings



THE BIG JOB OF A LITTLE SPRING

IN MASS WAR PRODUCTION!

★ Seldom noticed, perhaps, is the counterbalance spring of the Racine High Speed Saw, shown above. But what an important part it plays in 24-hour-a-day production schedules!

Designed especially for this heavy-duty saw by Muehlhausen spring technicians, it is a vital part of the simplified finger-tip control, which speeds up production by cutting down handling and loading time. This spring has all the ruggedness to withstand the rough treatment of unskilled men, yet has the accuracy required for careful counterbalancing—so necessary for ease of manipulation by women operators.

You can always depend upon Muehlhausen to produce springs of unvarying precision and accuracy for any application; springs of any type—compression, extension, torsion or flat—hot or cold formed. Call, write or wire for facts today!

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CAN WE HELP YOU?
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SEND FOR TWO NEW FOLDERS—FREE

New Die Spring Bulletin illustrates, describes 206 sizes and types of die springs.

New Armament Bulletin shows importance of springs for many types of war equipment.

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NEW, REVISED REEVES CATALOG

REEVES
VARIABLE
SPEED CONTROL
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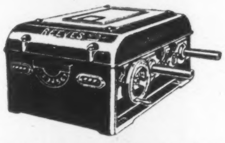
NEW— Reducer-Type Transmission

NEW— Vari-Speed Jr.

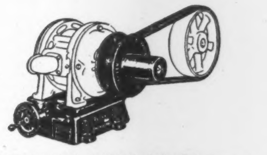
NEW— Sizes and Speed Ratios

NEW— Diagrams and Tables

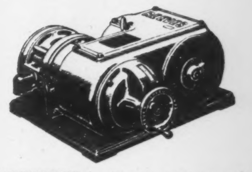
This book is more than a catalog. It is a complete, authoritative textbook on variable speed control, issued by Reeves, originators of the Variable Speed Transmission and recognized leader in the specialized field of speed control engineering. Its 128 pages are packed with practical information for manufacturers in every line of industry. This book gets right down to the fundamentals of accurate speed control—what it is—how engineered and applied—the remarkable advantages it offers. Contains over 200 illustrations, diagrams, and tables. It is written out of the experience of Reeves engineers in applying infinite speed adjustability to more than 260,000 machines in all types of plants. Regardless of what you manufacture, you will find this book valuable and helpful. Since it is being distributed only to those who request it, use coupon below.



VARIABLE SPEED TRANSMISSION for providing infinite, accurate speed flexibility over wide range.



VARI-SPEED MOTOR PULLEY converts any standard constant speed motor to a variable speed drive.



MOTODRIVE combines motor, speed varying mechanism and reduction gears in single compact unit.

A COMPLETE, AUTHORITATIVE TEXTBOOK ON

Speed Control—

Here are a few of many features that make it important for you to have this book.

A clear, concise explanation of the necessity for variable speed control in modern manufacturing processes.

Information on new REEVES Reducer-Type Transmission, which combines accurate speed adjustability and speed reduction in one compact unit.

Full description of the REEVES Vari-Speed Jr., a light weight, light h.p. simplified unit which utilizes standard section V-belts.

New sizes and speed ratios of REEVES Motodrive and Vari-Speed Motor Pulley.

Requisites of modern speed control equipment—a valuable check-list to use in selecting the proper unit for your needs.

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Engineering data in convenient, reference form—tables for selecting correct size and speed range, dimension diagrams and other installation information.

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Send copy of your new, revised Catalog-Manual G-435, on Variable Speed Control.

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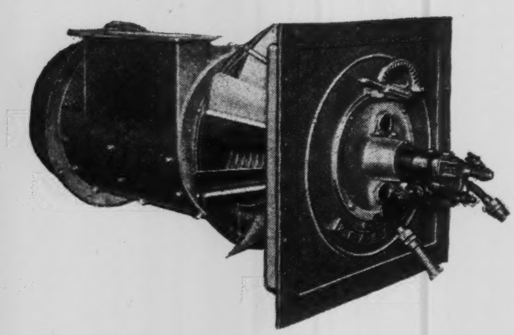
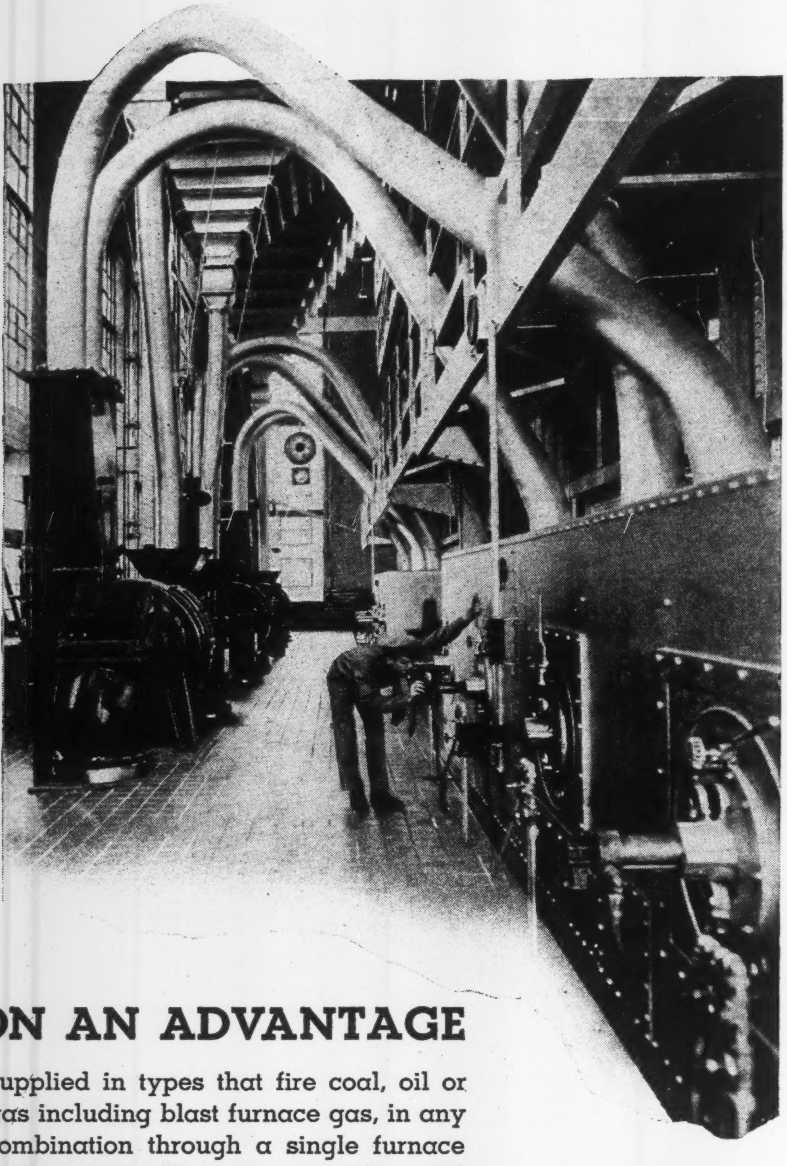
Combined Pulverized Coal and Wide Range Oil Burner.





Install the
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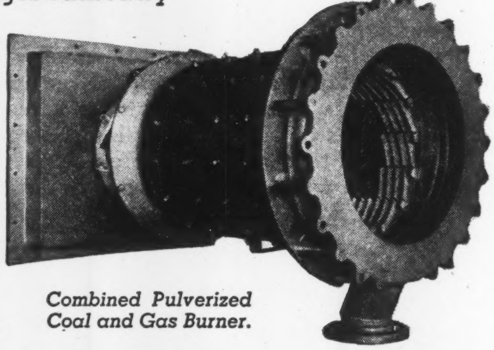
MAKE FUEL CONVERSION AN ADVANTAGE

PEABODY has been building burners for firing pulverized coal since 1924. Advances in design and materials of construction have kept pace all these years with progress in steam generating equipment. This is important now when increased coal firing of boilers has become necessary to conserve other fuels.

The Peabody Coal Burner, due to the manner in which fuel and air are controlled, produces a short, extremely turbulent flame, which results in highly efficient combustion.

Peabody Combined Fuel Burners are supplied in types that fire coal, oil or gas including blast furnace gas, in any combination through a single furnace wall opening. They eliminate the need for future equipment changes caused by fuel shortages and give the widest flexibility in the choice of fuels for the life of the boiler.

Discuss your combustion problems with Peabody engineers, who have concentrated on burner equipment for many years.



Combined Pulverized Coal and Gas Burner.

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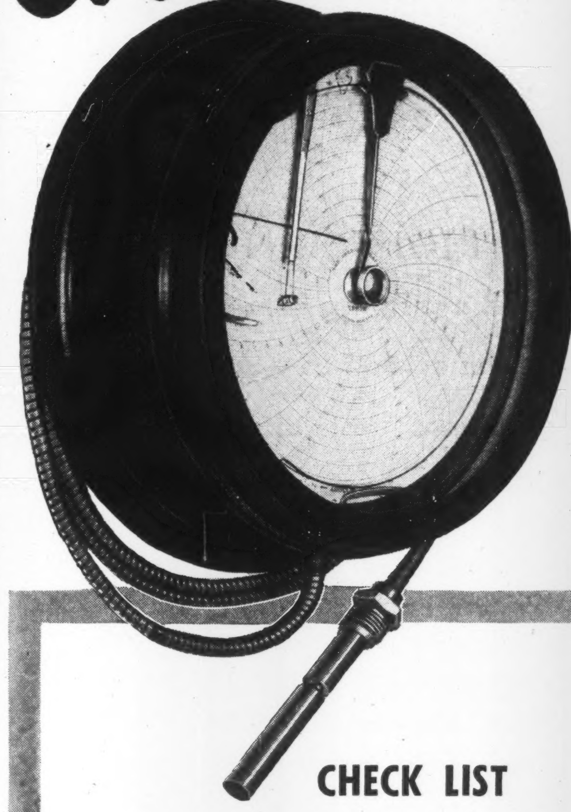

to improve your production through temperature records!

CHECK LIST

A few major temperature points where records from Foxboro Temperature Recorders often reveal opportunities for important production improvements:

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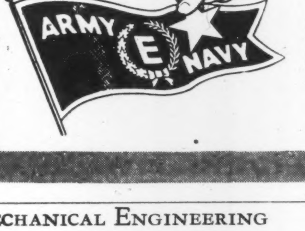

A STAR IS ADDED . .

For continued outstanding production, The Foxboro Company has won renewal of the Army-Navy "E" Award.

Is it worth a few minutes of your time to stop important losses in your output, wastes of fuel, or spoilage of materials? All you need to do is review the critical temperature points in your equipment, and make sure you're getting daily records that "show up" such production losses!

No matter what step in your operation demands uniform temperature, Foxboro Temperature Recorders will automatically give you exact information to save quality-variations, spoilage and re-runs. Their ultra-sensitive thermal system reacts instantly to slightest temperature deviations. Their light, strong mechanism "writes it down" *accurately* for years, without attention except routine chart changes.

The Foxboro Temperature Recorder is one instrument you can always depend on. Precision-engineered for accuracy, endurance and trouble-freedom, it gives the facts at minimum cost per year! Write for full details in Bulletin 198-2. **The Foxboro Company, 182 Neponset Avenue, Foxboro, Massachusetts, U. S. A.**

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TEMPERATURE RECORDERS

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. . IT'S LUBRICATION OF THE RIGHT KIND that will keep production machines in good operating condition and continuously on the job. Idle machines due to worn bearings, gears or chains, caused by improper lubrications are certainly on the blacklist these days . . . and remember that machine replacement parts are most difficult to get. Yes—the No. 1 essential today is proper lubrication.

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7 QUICK FACTS ABOUT LUBRIPLATE LUBRICANTS

1. *LUBRIPLATE produces an ultra-smooth, wear-resisting bearing surface.*
2. *LUBRIPLATE reduces friction, thus lowering maintenance and power costs.*
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6. *LUBRIPLATE is economical—a little goes a long way.*
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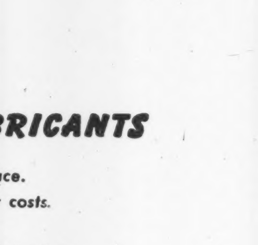

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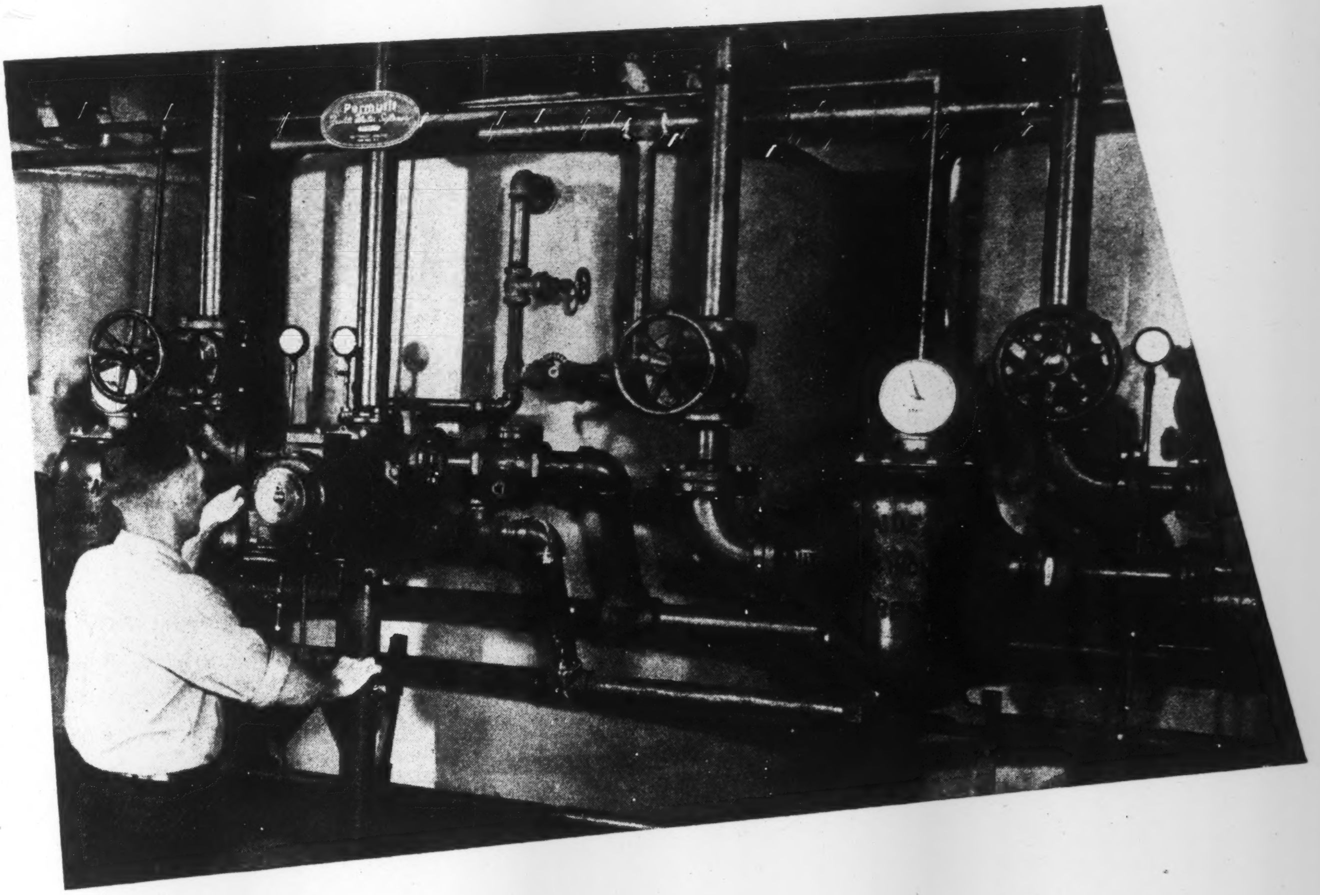
THE MODERN LUBRICANT *that Arrests Progressive wear*

BETTER WATER HELPS *the flying horse* PULL A BIG WAR LOAD



Permutit ZEO-KARB* water softeners prevent boiler scale at Socony-Vacuum.

THESE Zeo-Karb Na water conditioners are installed at a Socony-Vacuum refinery. Zeo-Karb removes both hardness and bicarbonates from feedwater before it enters the boilers. The effluent is reduced in total solids, and alkalinity is held at the desired value.

Control of water quality by Permutit equipment is protecting thousands of war plants against slowdowns, waste of fuel and damage to irreplaceable equipment. Write us about your water problem. The Permutit Company, Dept.A3,330 West 42nd Street, New York 18, N. Y. In Canada: Permutit Company of Canada Ltd., Montreal.

*Trade-mark Reg. U. S. Pat. Off.

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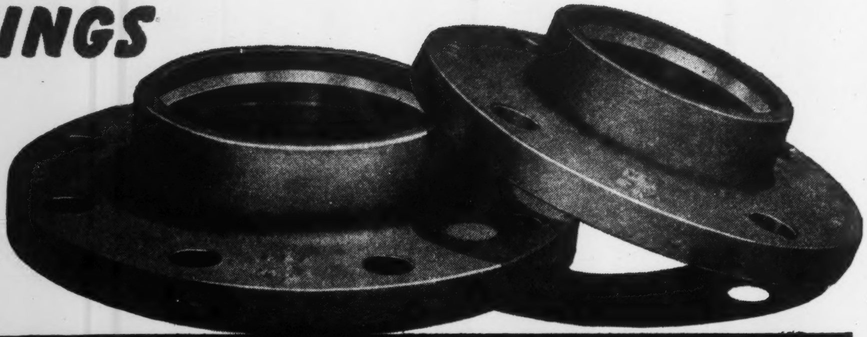
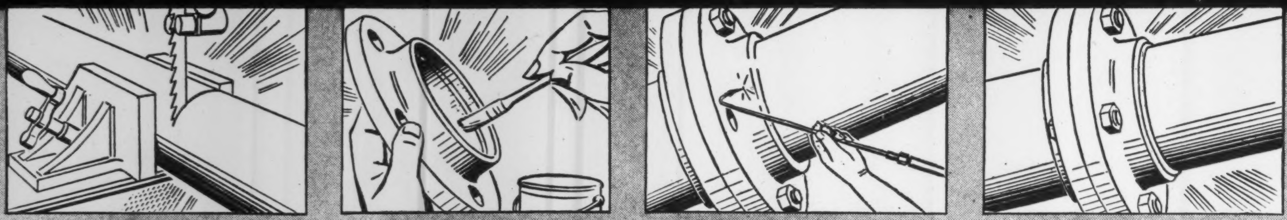
USE WALSEAL FLANGES, FITTINGS AND VALVES!



. . . THE MODERN METHOD OF JOINING COPPER OR BRASS PIPE AND TUBING



Cut pipe or tubing square, making certain that the pipe is not squeezed out of round or made undersize.

After cleaning flange and pipe carefully, apply flux to the flange recess and to the pipe or tubing.

Expand pipe by heating with the oxyacetylene flame. Next heat section of flange hub; then heat both pipe and flange hub section with wiping motion of torch.

Repeat process on adjacent flange hub and pipe sections. The joint is completed when a fillet of silver brazing alloy shows entirely around pipe at edge of hub.

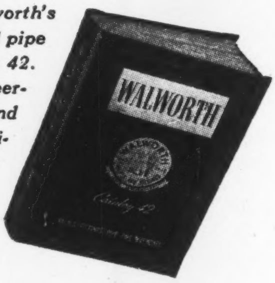
You can save installation time and assure strong, permanent assemblies by using Walseal flanges, fittings and valves. As illustrated in the sketches above, four simple steps connect a flange to the pipe with a silver brazed joint that is tight, leak-proof, and has a corrosion resistance equal to that of the pipe or tubing itself.

Walseal flanges are completely machined, faced, and drilled before brazing so that the assembly is ready to go into the line immediately after brazing. No refacing is required after heating because the relatively low brazing temperatures do not cause any warpage of the flange faces.

Joints made with Walseal flanges, fittings, and valves are not solder joints, but are Silbraz joints. That means that they cannot creep or pull apart under any temperatures to which the pipe or tubing can be safely subjected.

For more complete information on how to install Walseal flanges, fittings, and valves, write for Booklet 84. Address: Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

You'll find pertinent information on Walworth's complete line of valves, fittings, pipe, and pipe wrenches in the new Walworth Catalog 42. Included are 78 pages of practical engineering data that simplify valve selection and make piping layouts easier. Write, on business stationery, for your free copy. Ad- Dept. No. D 15



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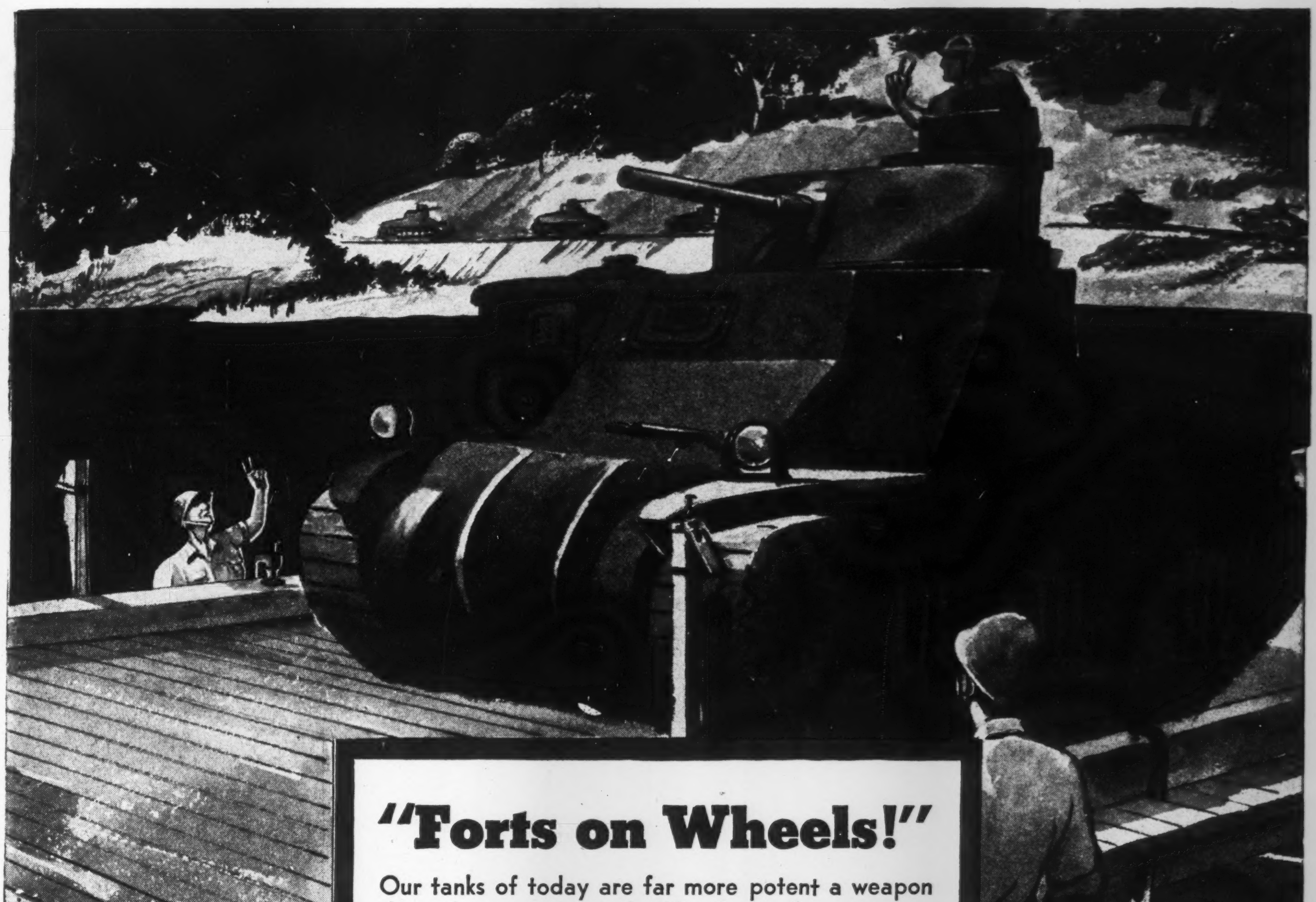

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Our tanks of today are far more potent a weapon than the permanent fortifications of yesteryear. Weighing as much as a small locomotive, they go anywhere with speed, making their own roads.

How these massive "mountains of metal and machinery" withstand the terrific stresses they encounter is a testimonial to American ingenuity.

The answer is found in their construction — the sound choice of metals and parts best able to withstand such abuse. More than ever before, *forgings* are in evidence in the tanks of today. Metals formulated to produce strength are rendered *tougher* and *stronger* by hammering and heat-treating. Forged to resist breakage from twisting, stretching, pressure and vibration.

Much of our output of drop and flat die forgings has gone into tank production. The reduced tank building program makes available upset and flat die forging facilities. We can take care of your forging requirements now. Send blueprints for quotation.

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Proudly we fly the Army and Navy "E" flag with three stars, awarded for excellence and proficiency in the production of war materiel.

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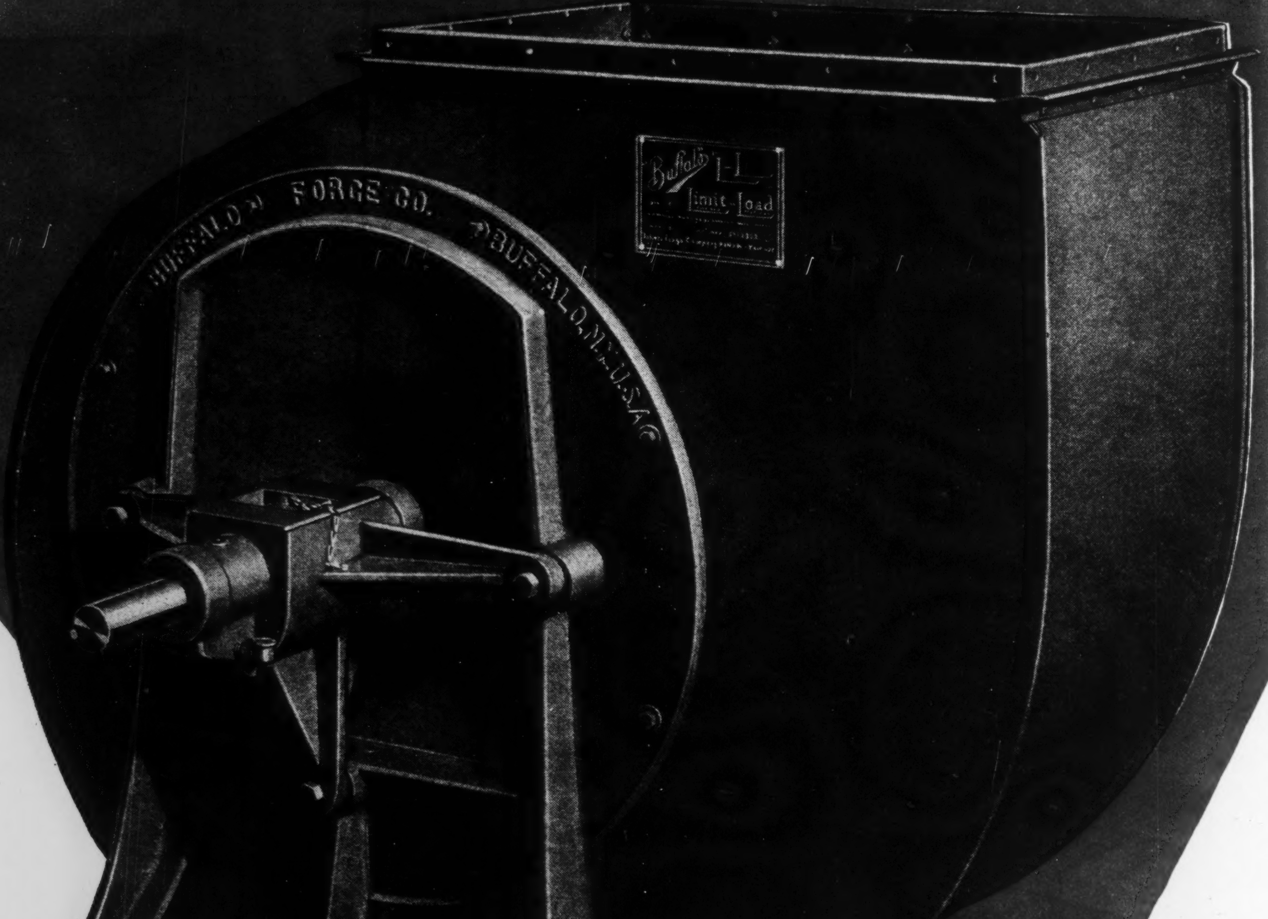
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mit L

"Buffalo"
TYPE "LL"
LIMIT LOAD
FAN

BUFFALO F

the "HEART"...

# of any ventilating system

...WITH A "Buffalo" FAN

that system is always up to par

e extensive network of ventilating ducts but little value—until the fan brings it to fe." That is why the fan you install is so vital effective ventilation.

Will that fan get full volume circulation through the entire system, in spite of obstructions?

Will that fan measure up to the demands for 24-hour-a-day operation?

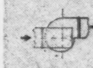
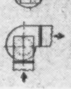
Will that fan serve quietly, with minimum attention and maintenance?

hese are practical questions. The improved uffalo" Type "LL" Limit Load Fans are the actical answer.

he chart to the right explains why. On the sis of practical, on-the-job tests, these improved "Buffalo" ns not only measure up to Standard Code Ratings—they liver when the actual pressure conditions in the system ry from specifications. Here's a development in fan engi- ering that's changing "ventilation thinking." Let us send u full engineering data *now* on "Buffalo" Type "LL" mit Load Fans for the "heart" of your ventilating system.

UNDER ACTUAL OPERATING CONDITIONS

The data below is based on a fan outlet velocity of 1600 feet per minute. The obstructions tested represent conditions of actual installations.

	Obstruction	Static Pressure	Percent Reduction in Capacity Buffalo Type "LL"	Competitive Forward Curve
	Elbow on Fan outlet	1"	3	7
		¾"	3	7
		½"	3½	11
	Elbow on inlet from left side	1"	2½	8½
		¾"	2	11
		½"	3	17½
	Elbow on inlet from right side	1"	1½	5
		¾"	1½	6
		½"	2½	7
	Elbow on inlet from top	1"	2½	5
		¾"	2	6
		½"	3	7
	Elbow on inlet from bottom	1"	1½	5
		¾"	1½	6
		½"	2½	7

Specify "Buffalo"

"First For Fans"

FORGE COMPANY

148 MORTIMER STREET • BUFFALO, NEW YORK
Canadian Blower & Forge Company, Ltd., Kitchener, Ontario

Bearing Breakdown?
SKF

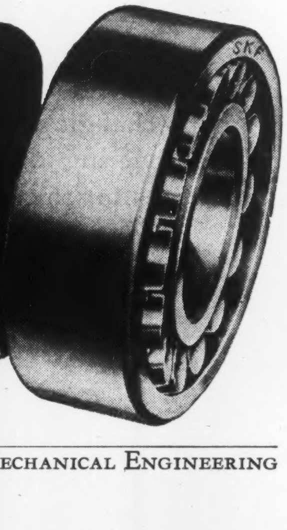
Your **SKF** Distributor is a trained trouble-shooter!

When bearing breakdown threatens vital machines with idleness, get hold of the authorized SKF Distributor . . . and get him fast. He's a trained trouble-shooter, a bearing specialist who *knows* his job.

This *know-how* is doubly important today. Because so much of SKF's capacity goes directly into vital war equipment, the distributor cannot always supply the exact bearing required for each replacement job.

But give him the slightest leeway, and he'll be able to provide a bearing which will keep your machine rolling. Your SKF Distributor is a trained *trouble-shooter.* Let him solve your bearing problems.

5434

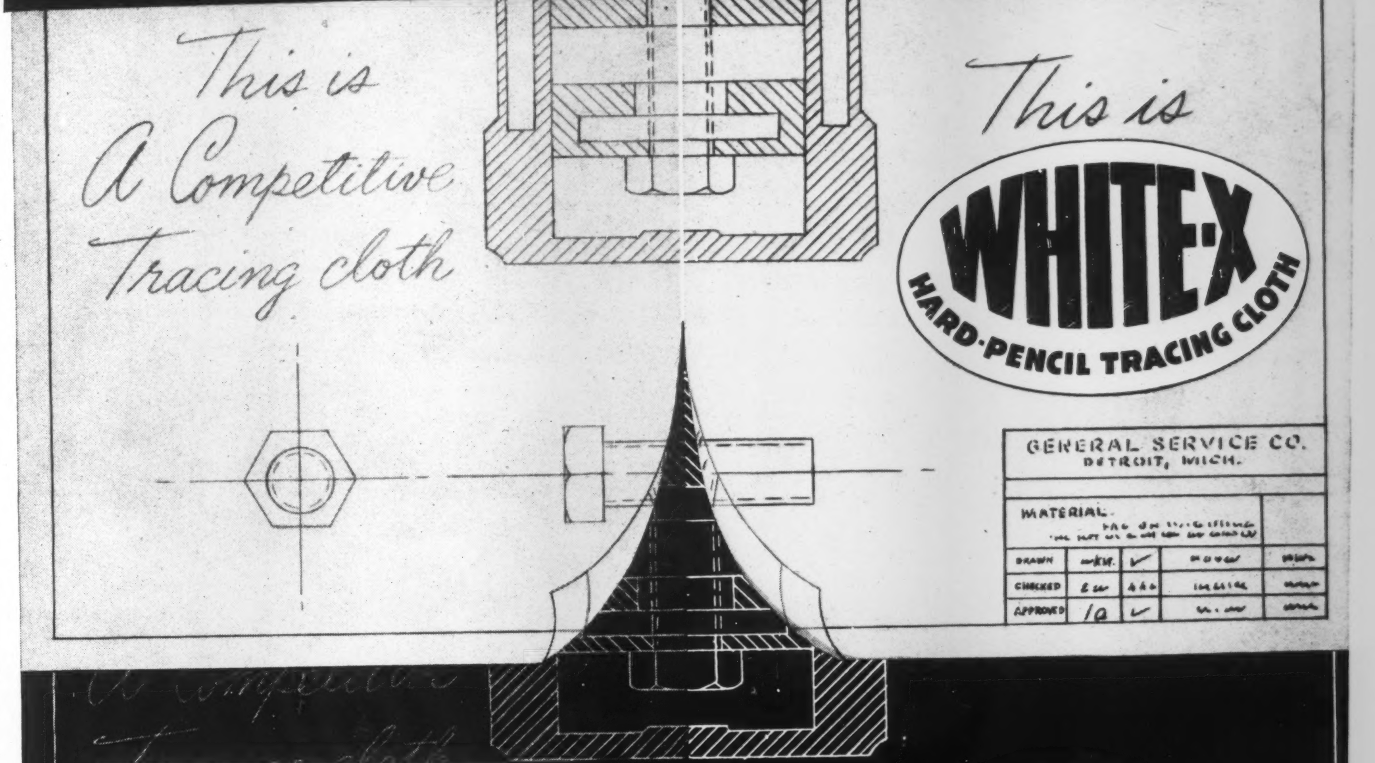


SKF

BALL AND ROLLER
BEARINGS

SKF INDUSTRIES, INC., PHILA., PA.

THIS ACTUAL PHOTOGRAPHIC REPRODUCTION SHOWS ONLY PART OF WHITE-X SUPERIORITY



MOISTURE-RESISTANCE, DUSTLESS BACK, "SEE-EASY" TRANSPARENCY ARE WHITE-X EXTRAS

On-the-board is the way to prove White-X. Your hands will "feel" the surface that takes hard pencil line with such fidelity—solid and opaque. Your eyes will enjoy that glass-like transparency and you can be proud, justifiably, of the clean, crisp drawings you produce—quickly! You'll see your prints sharply improved in detail, in unvarying background density, in finished appearance. You'll enthuse over White-X from the first pencil stroke. Free samples? We'll be glad to send them—for the asking.

POST

FOR IMMEDIATE DELIVERY

Fine tracing media and sensitized papers ready for delivery from the following cities. Just phone

Atlanta	JACK. 2121	Los Angeles	MUT. 2341
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Chicago	KEY. 7000	New York	WIS. 7-7678
Cincinnati	MAIN 2664	Oklahoma City	3-6306
Cleveland	CHE. 7347	Omaha	ATLANTIC 7890
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Dallas	RIVERSIDE 4403	Pittsburgh	ATL. 3350
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Hollywd	GRANITE 4188	Seattle	MAIN 4022
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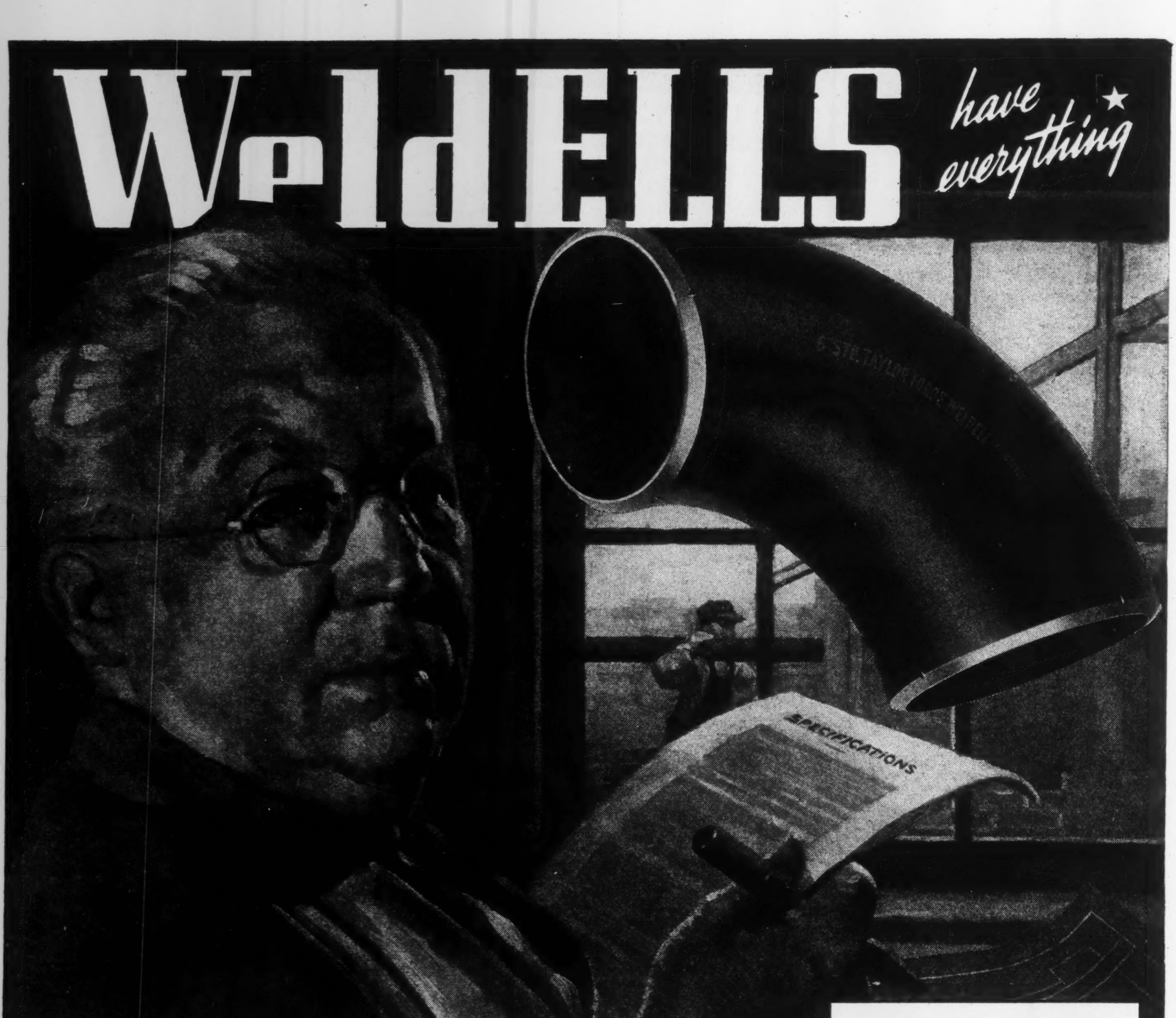
or by mail or phone to our Chicago office.

The Frederick Post Co.

Phone KEYSTONE 7000 · CHICAGO



"In my business little things make a big difference!"

ON the surface a piping contractor's work looks simple: Just size up the specs and figure out a bid that will take the job!

But that's only the way in. If you want to do a good job and come out right on it, you've got to make every move count. And you can't do that unless you're working with the right kind of stuff.

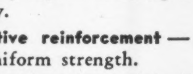
Take welding fittings: If WeldELLS* are specified I know the job will *move.* It will move because those permanent markings of size and weight on every fitting stop the groping, the false starts and the mistakes—because those accurate quarter-markings help to guide the work—because the tangents make lining up easy—because the bright, lathe-cut bevels enable the welder to do a better job faster.

When I say this, I'm not overlooking the specifier's end of the job, either. It seems to me that any engineer will concede that WeldELLS are *more* than "equal" to any other fittings on a purely engineering basis.

For better welded piping at lower cost give me WeldELLS—the welding fittings that have *everything!*

★ WeldELLS alone have all these features:

- **Seamless** — greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.



WeldELLS are just one of many Taylor Forge products that are vital to war and victory. An example is huge rolled steel rings—an important part of U. S. tanks now in action.

* WeldELLS and many other Taylor Forge products are produced in Byers Genuine Wrought Iron.

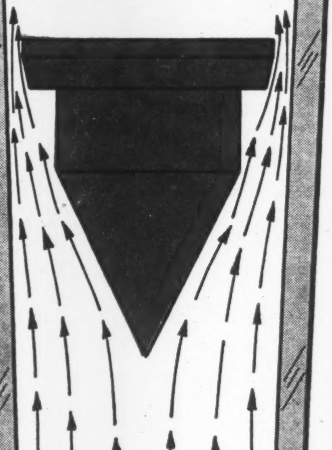
TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P. O. Box 485
NEW YORK OFFICE: 50 CHURCH ST. • PHILADELPHIA OFFICE: BROAD ST. STATION BUILDING

The ROTAMETER

—its basic advantages over head-type meters

8 BASIC ADVANTAGES

1. Metering elements and fluid being metered clearly visible
2. Wide flow range—20-to-1 easily obtained
3. Evenly spaced scale divisions—no compression of scale at low flows
4. Low, constant pressure drop—reduces pumping costs
5. New Stabl-Vis rotameter compensates for viscosity and density variations
6. 10″ to 24″ travel of metering float—accuracies correspondingly high
7. Instantaneous response to flow change—no friction or hysterisis
8. Measures corrosive gases, liquids and slurries that no other meter will handle accurately



Are you trying to cut power costs? Are you seeking stable process conditions? Do you sometimes operate with precious little available head? Silly questions! Of course, you do, and therefore we would like you to consider the

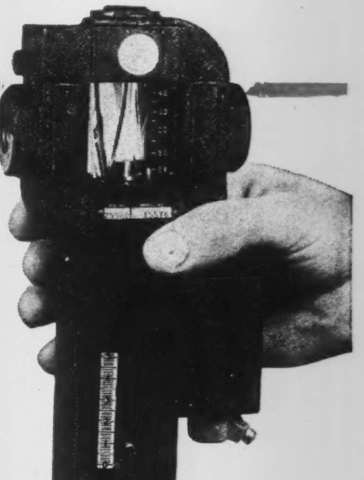
Low and constant pressure drop

of the rotameter. As the rotameter float rises, the area for flow passage increases so that the flow never has a fixed constriction thru which to force its way.

The pressure drop across the float is low and constant throughout the entire flow range of the rotameter.

Consequently in many plants Fischer & Porter Rotameters are definitely paying their way thru lowered pumping costs, and doing their gentle bit to keep touchy processes quietly soothed by a minimum of pressure fluctuations. Often they are the only meters that may be used because of the low total pressure available.

Do you know all the advantages that are making Fischer & Porter Rotameters *the* flow rate measuring instrument? Our new booklet, "A New Era in Flow Rate Measurement," will tell you why. It's very comprehensive yet "awfully" easy to read because it's done in a semi-humorous, "catch-as-catch-can" cartoon style which we hope will appeal to you. It's free, so why not send for it?



NEW FLOW ALARM . . . positive . . . inexpensive

The float in the Rota-Sight alarm moves up or down in direct proportion to flow rate changes. At any points you may choose in the flow range it will operate an electrical switch to light an electric lamp, to sound an alarm, or to stop or start electrical equipment. Positive . . . accurate . . . dependable. Cast in all metals from ¼″ size and up. Available also without the alarm attachment as a flow rate indicator. Send for bulletin 92-A which gives the interesting details. Fischer & Porter Company, 3111 County Line Road, Hatboro, Pa.

You will be able to see our latest developments at BOOTH 304-306—CHEM. SHOW, NEW YORK—DEC. 6 to 11.

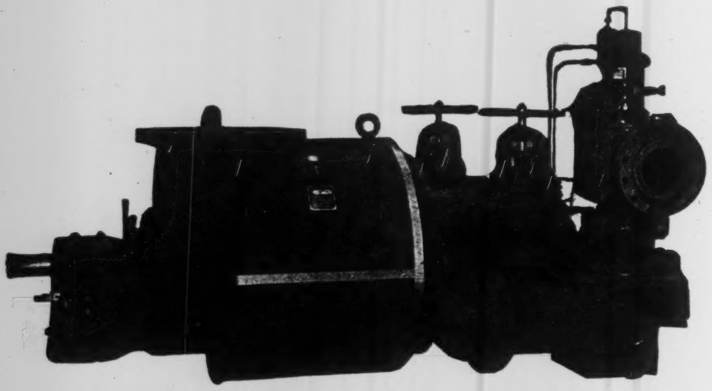
FISCHER & PORTER CO.

712 COUNTY LINE ROAD, HATBORO, PA.

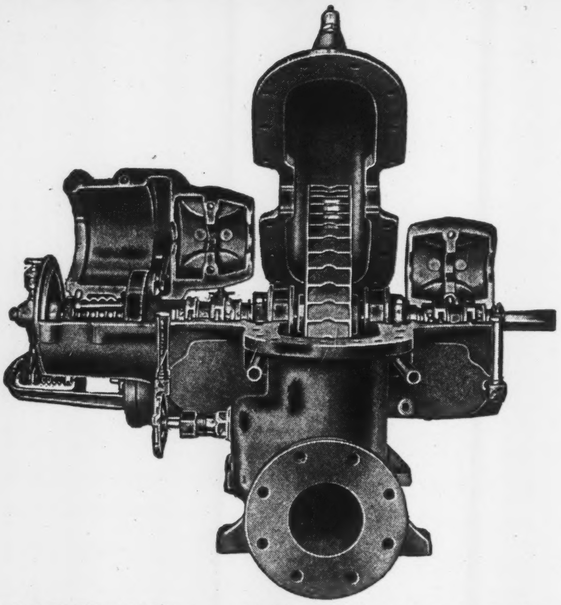
RATE OF FLOW INDICATING, RECORDING OR CONTROLLING ROTAMETERS FOR ANY LIQUID OR GAS

TERRY

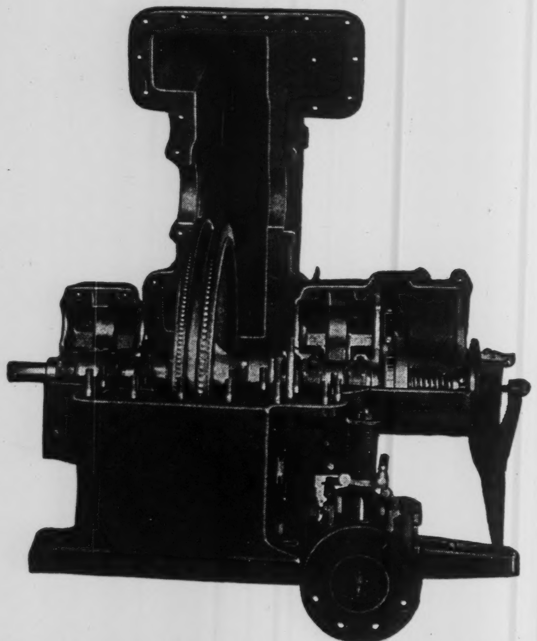
OFFERS COMPLETE COVERAGE OF MECHANICAL DRIVE TURBINES



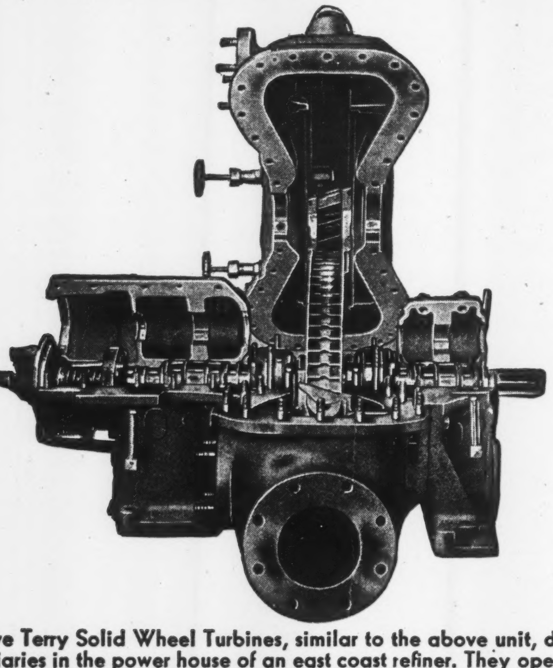
1200 Horsepower Terry Multi-stage Turbine. Units of this type are employed extensively for driving large pumps. The units may be designed for non-condensing, condensing, mixed pressure, or bleeder operation. They may be equipped with constant speed or variable speed governors, remote speed controls or with special governors to meet unusual requirements. Ask for Bulletin SR-114.



Terry Solid Wheel Turbine with Top of Casing Raised. Note the ruggedness and the ease with which the interior parts can be inspected — one of the country's leading oil companies employs 308 of these units for driving various types of refinery pumps. Full details are available in Bulletin S-116.



Axial Flow Impulse Terry Turbine — one of a complete line — built with either two or three rows of blading. These units, like all Terry turbines, are the result of over 45 years of successful experience in the manufacture of turbine drives exclusively. Completely described in Bulletin S-107.



Twelve Terry Solid Wheel Turbines, similar to the above unit, drive auxiliaries in the power house of an east coast refiner. They operate with steam at 625 lbs. pressure — 700° Total Temperature. Eight of the machines exhaust against 125 lb. back pressure. The first of these units was purchased in 1931. It proved entirely satisfactory so that as the plant was enlarged, duplicate Terry's were added. Bulletin S-99.

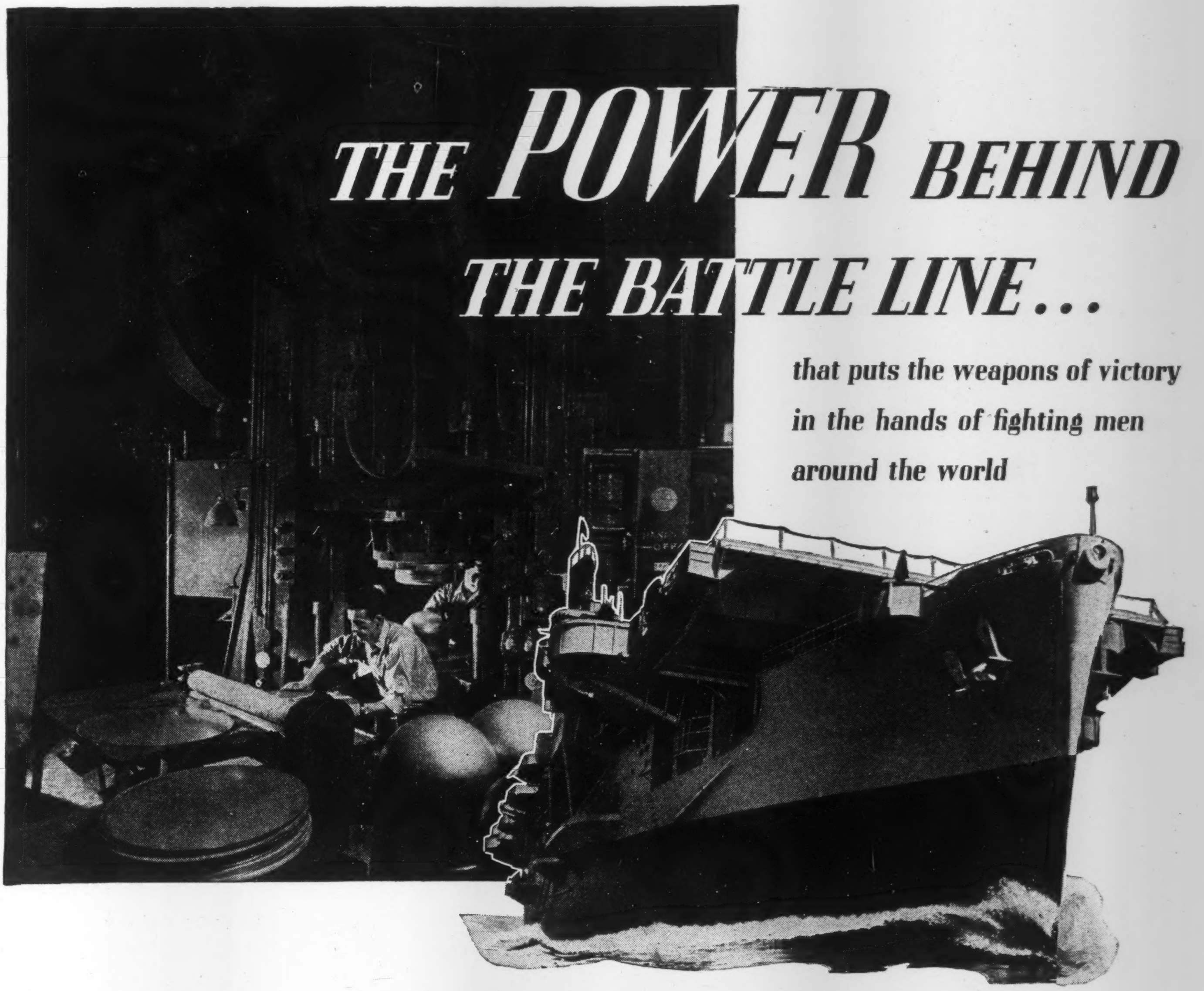
T-1151

THE TERRY STEAM TURBINE CO.

TERRY SQUARE
HARTFORD, CONN.

THE *POWER* BEHIND THE BATTLE LINE . . .

that puts the weapons of victory in the hands of fighting men around the world



Bombers, tanks, shells, bazookas—all the thousand and one items of supply vital to the war—pour out of America's factories in tremendous quantities . . . Ships go down the ways at a rate the world had not even dreamed of . . .

And to back the great attacks now beginning, America's war production must rise to still greater heights this year.

The entire TODD COMBUSTION EQUIPMENT organization is proud to be playing its part in this mighty effort.

For 30 years TODD burners have won for themselves a unique reputation for continuous and efficient production of power and heat, both on land and sea. Since Pearl Harbor, TODD has met, and is now constantly meeting, the enormous demands for efficient combustion equipment for new and converted war plants, and the rapidly growing Navy and Merchant Marine!

All TODD burners today are on high priority. But when victory is won, the company will again serve the many organizations who today cannot obtain combustion equipment—commercial buildings, plants manufacturing civilian goods, churches and schools.

New research development, born of the war, will enable TODD to provide still greater efficiency and economy in boiler plant operation on both land and sea.

TODD SHIPYARDS CORPORATION

TODD COMBUSTION DIVISION

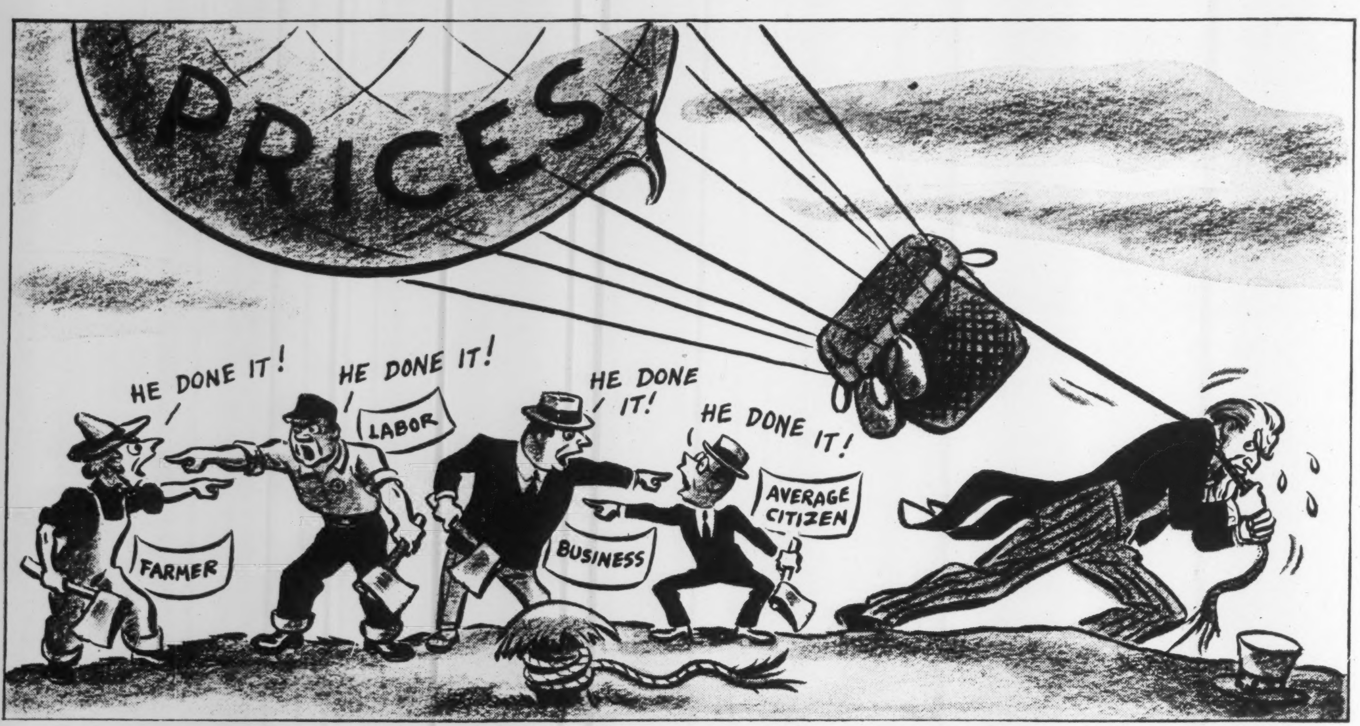
601 West 26th Street, New York 1, N. Y.

NEW YORK ★ MOBILE ★ NEW ORLEANS ★ GALVESTON
SEATTLE ★ BUENOS AIRES ★ LONDON

Turn every heat unit into useful power or heat! Fuel waste is sabotage.

ON THE FIRING LINE OF AMERICA'S WAR PRODUCTION FRONT

TODD BURNERS



Never mind "who done it"—pitch in and help *get* it down!

THIS IS YOUR UNCLE SAM talking—but I'm going to talk to you like a DUTCH uncle, to keep all of us from going broke.

Ever since the Axis hauled off and hit us when we weren't looking, prices have been nudging upwards. Not rising awfully fast, but RISING.

Most folks, having an average share of common sense, know rising prices are BAD for them and BAD for the country. So there's been a lot of finger pointing and hollering for the OTHER FELLOW to do something—QUICK.

The government's been yelled at, too. "DOGGONNIT," folks have said, "WHY doesn't the government keep prices down?"

Well, the government's done a lot. That's what price ceilings and wage controls are for—to keep prices down. Rationing helps, too.

But let me tell you this—we're *never* going to keep prices down just by leaning on the government and yelling for the OTHER FELLOW to mend his ways.

We've ALL got to help—EVERY LAST ONE OF US.

Sit down for a minute and think things over. Why are most people making more money today? It's because of the SAME cussed war that's killing and maiming some of the finest young folks this country ever produced.

So if anyone uses his extra money to buy things he's in no particular need of . . . if he bids against his neighbor for stuff that's hard to get and pushes prices up . . . well, sir, he's a WAR PROFITEER. That's an ugly name—but there's just no other name for it.

Now, if I know Americans, we're not going to do that kind of thing, once we've got our FACTS straight.

All right, then. Here are the seven rules we've got to follow as GOSPEL from now until this war is over. Not some of them — ALL of them. Not some of us — ALL OF US, farmers, businessmen, laborers, white-collar workers!

Buy only what you need. A patch on your pants is a badge of honor these days.

Keep your OWN prices DOWN. Don't ask higher prices—for your own labor, your own services, or goods you sell. Resist all pressure to force YOUR prices up!

Never pay a penny more than the ceiling price for ANYTHING. Don't buy rationed goods without giving up the right amount of coupons.

Pay your taxes willingly, no matter how stiff they get. This war's got to be paid for and *taxes are the cheapest way to do it.*

Pay off your old debts. Don't make any new ones.

Start a savings account and make regular deposits. Buy and keep up life insurance.

Buy War Bonds and hold on to them. Buy them with dimes and dollars it HURTS like blazes to do without.

Start making these sacrifices now—keep them up for the duration—and this country of ours will be sitting pretty after the war . . . *and so will you.*

Uncle Sam

KEEP PRICES DOWN!

Use it up • Wear it out
Make it do • Or do without

This advertisement, prepared by the War Advertising Council, is contributed by this publication in co-operation with the Magazine Publishers of America.

Silenced...the sparks in Sparks' Ears

Yes . . . sparks had to be banished from Sparks' ears, for today radio communication is by voice. Voice communication from crew member to crew member. From pilot to pilot. From squadron leader to squadron leader. From Air General to every one of 9,000 airmen aloft in a 1,000 plane formation.

- Spark signals from the high tension ignition systems of aircraft would completely blot out radio voices. The ignition cables must be completely shielded—electrically and mechanically. Titeflex flexible metallic tubing is doing that job.
- But, what has this to do with *your* problem?
- *You may be responsible* for a vastly different product. But consider this Titeflex aircraft application as a performance test of flexible metal tubing . . . think of it in terms of your own flexible connection problems.
- Titeflex in aircraft performs on the front of the engine directly in a wind stream of over 300 miles per hour. It vibrates in mid-air under the full military power of a 2000 hp engine running at top speed. Rain lashes it in torrents—at tornado force.
- Yet, Titeflex remains *tight* enough to shield an electrical current of 10,000 volts. And all this at sub-stratosphere temperatures of 50° below, outside the tubing. And 300° above, at the spark plug end.
- Could any use-test be more convincing—whether your problem be the conveyance of oil, gasoline, acid, gas, water, steam, or electricity?
- Ask our application engineers to tell you more about Titeflex not only for wartime applications but also for postwar use.

TITEFLEX METAL HOSE COMPANY
521 Frelinghuysen Ave., Newark, N. J.

Titeflex
FLEXIBLE...ALL-METAL TUBING!

Designing and Making Compressor Valves Since 1906

The story of our business is simple—we have done one thing well. We have designed and made plate valves for all types and sizes of ammonia, air and gas compressors from 3″ to 30″ bore.

We have sold VOSS VALVES to thousands of satisfied users who praise their performance.

We are craftsmen, engineers, mechanics who are proud of our products; our honor and integrity are put into our work.

Our VOSS VALVES have outstanding qualities—they guarantee capacity increase, power saving and safety of operation. Many users have sent us letters of approval.

Your compressors would also do much better with VOSS VALVES Write us about your compressors, tell us what their valves do; chances are their economy can be improved. Increased capacity and savings in power input combine to make an improvement in operating economy of 10% to 15% sometimes up to 20% and beyond.

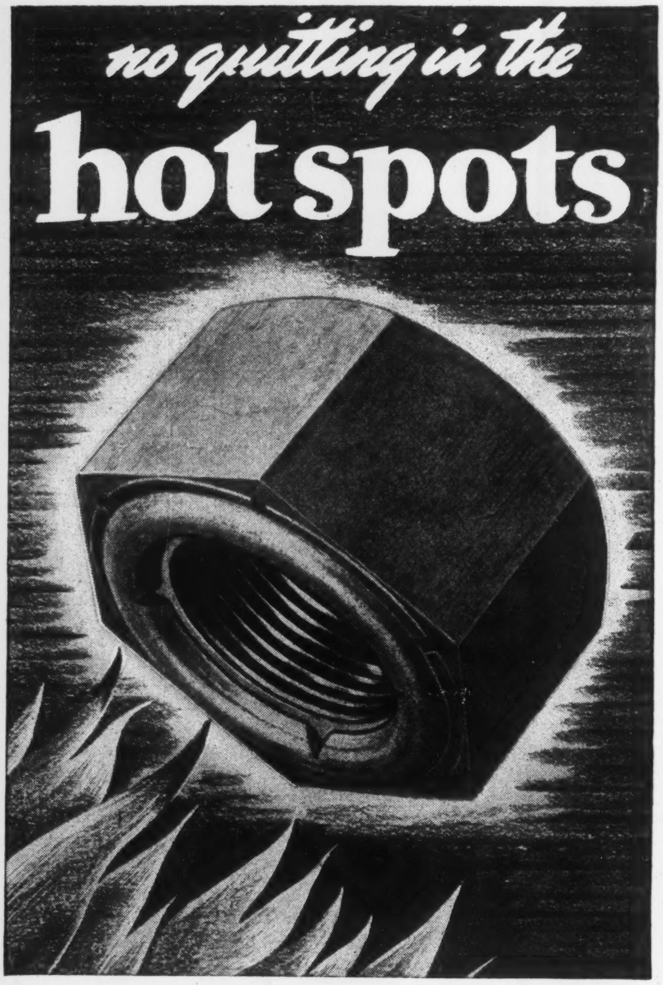
We are in the war too. But for the duration we have arranged for a quick repair service for emergency breakdowns. We can furnish promptly compressor valves for all types and sizes of ammonia, air and gas compressors. Also spares and replacement parts for valves made in foreign countries.

For estimates send samples or sketches of your old poppet valves or plate valves, give bore, stroke and speed of your compressors.

J. H. H.
VOSS VALVES
REG. U.S. PAT. OFF.

Make Compressors Run Better Than When They Were New!

J. H. H. VOSS CO.
785 East 144th St. New York, N. Y.

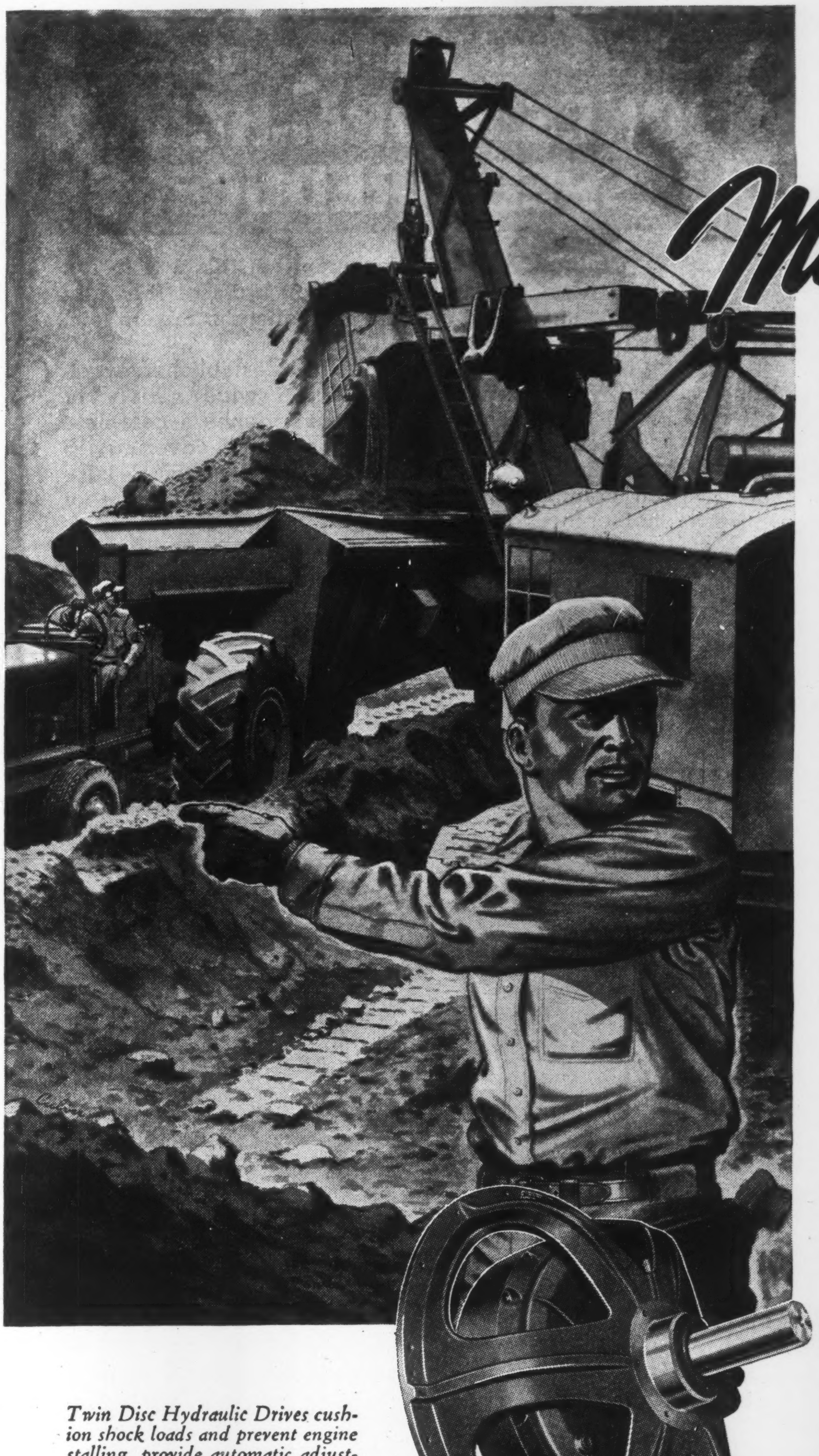


Heat does not affect the all-metal An-cor-lox lock nut up to the softening point of the metal. What's your specific application? The correct metals or alloys can be chosen . . . so that locking efficiency will be unimpaired, even on an extreme high-temperature job. ● Similarly, corrosion-resistant metals may be selected for this one-unit lock nut construction. ● Write for the An-cor-lox story on new locking security—also for An-cor-lox sample.

An-cor-lox
TRADE-MARK REG
Lock Nuts

An-cor-lox Division
LAMINATED SHIM COMPANY
Incorporated
93 Union Street • Glenbrook, Conn.

2056



Moving day FOR MOUNTAINS

With things as they are now, every day is moving day for millions of tons of coal and building material—for countless yards of dirt on road and building sites. Rapid, economical handling of mountains of raw material is essential to low-cost production of the goods which make people healthier, more comfortable, better fed. Coal, for example, would be higher-priced were it not for equipment which brings to its handling the strength and stamina of giants.

Wherever power shovels, cranes and draglines are used, there too you will find Twin Disc Clutches and Hydraulic Drives. In this field, as in so many others, the Twin Disc Clutch Company's quarter century of experience in industrial clutch design and manufacture adds to the store of knowledge needed to make man's work easier.

Here is one fact which has become crystal clear under conditions governing operation of industrial equipment today. Whether it's a tractor clutch or oil rig power take-off; a marine gear or hydraulic torque converter on a rail car, a power link built by Twin Disc adds more than its share to the stamina, endurance and dependability of the equipment on which it is used.

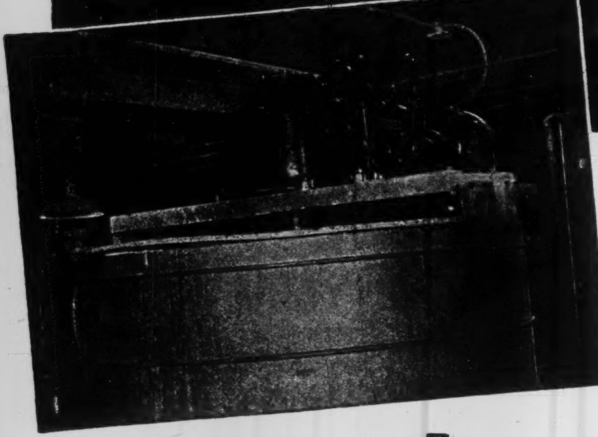
If you build, buy or use equipment having both driving and driven units, it will pay you to know Twin Disc Clutches and Hydraulic Drives well. Get in touch with Twin Disc engineers now for the kind of help and information which improves equipment performance and lowers operating costs. Twin Disc Clutch Company, Racine, Wisconsin, (Hydraulic Division, Rockford, Illinois).

Twin Disc Hydraulic Drives cushion shock loads and prevent engine stalling, provide automatic adjustment of speed to load so engine operates at its most efficient speed.

Power Take-off
Heavy Duty Clutch
Machine Tool Clutch
ARMY E NAVY
TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U.S. PAT. OFF.
Tractor Clutch
Marine Gear

For driving agitators, mixers and similar equipment—

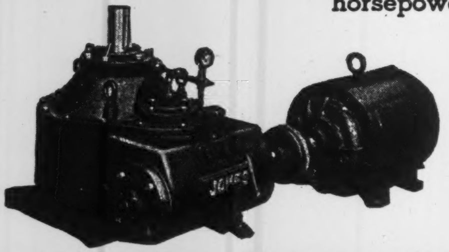
JONES WORM-HELICAL SPEED REDUCERS



HERE is a line of machines that fills a long felt need for double reduction units of the fully enclosed type to be used for agitators, mixers, etc. requiring a vertical shaft drive.

Many of these Jones units have established excellent performance records in a wide variety of service. As a result of that experience a complete standard line has been developed covering 15 standard ratios ranging from 40 to 1 to 250 to 1 for all common motor speeds and a wide range of horsepower ratings.

● This Jones Worm-Helical Speed Reducer on a lacquer agitator is typical of the wide range of services for which these drives can be used such as ore roasters, pulp tank mixers, furnaces, bending rolls and similar applications.

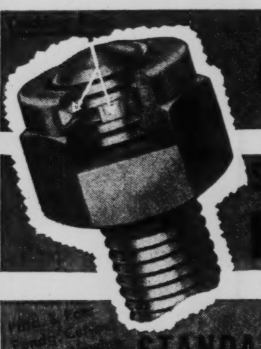


The new Jones Bulletin No. 75 covers complete details on these new Worm-Helical Speed Reducers, with rating tables, dimension diagrams, torque charts and other application information. We shall be pleased to send you a copy.

W. A. JONES FOUNDRY & MACHINE CO.
4427 Roosevelt Road, Chicago, Illinois

Jones

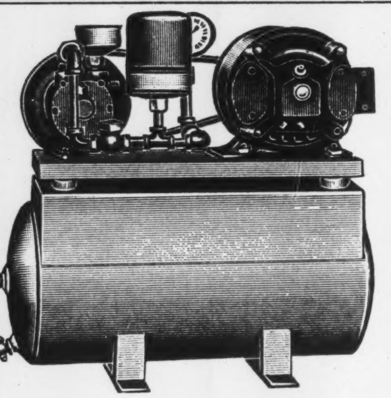
HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS • PULLEYS
CUT AND MOLDED TOOTH GEARS • V-BELT SHEAVES • ANTI-FRICTION
PILLOW BLOCKS • FRICTION CLUTCHES • TRANSMISSION APPLIANCES



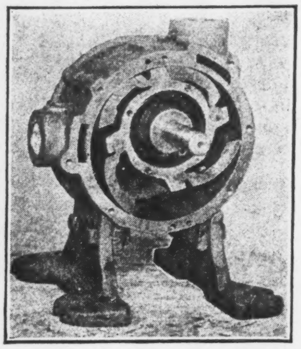
UNSHAKO
Reg. U. S. Pat. Off.

SELF LOCKING NUT
HOLDS TIGHT

STANDARD PRESSED STEEL CO.
BOX 558 JENKINTOWN, PENNA.



Automatic
VACUUM
CONTROL
LEIMAN BROS.
VACUUM
PUMPS
-Non-fluctuating-



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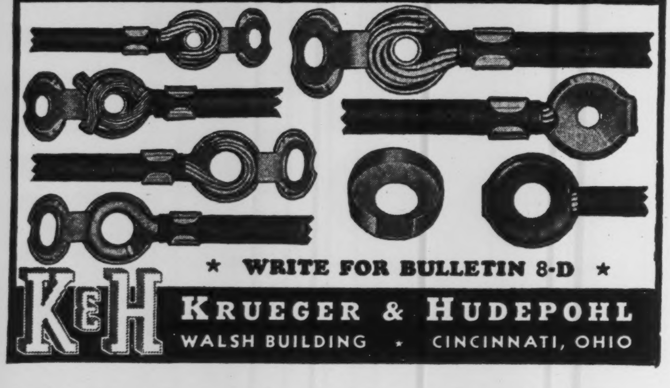
With or Without Insulation Grip—Small or Large Screw Hole
For Standard, Extra Flexible Stranding and Solid Wire



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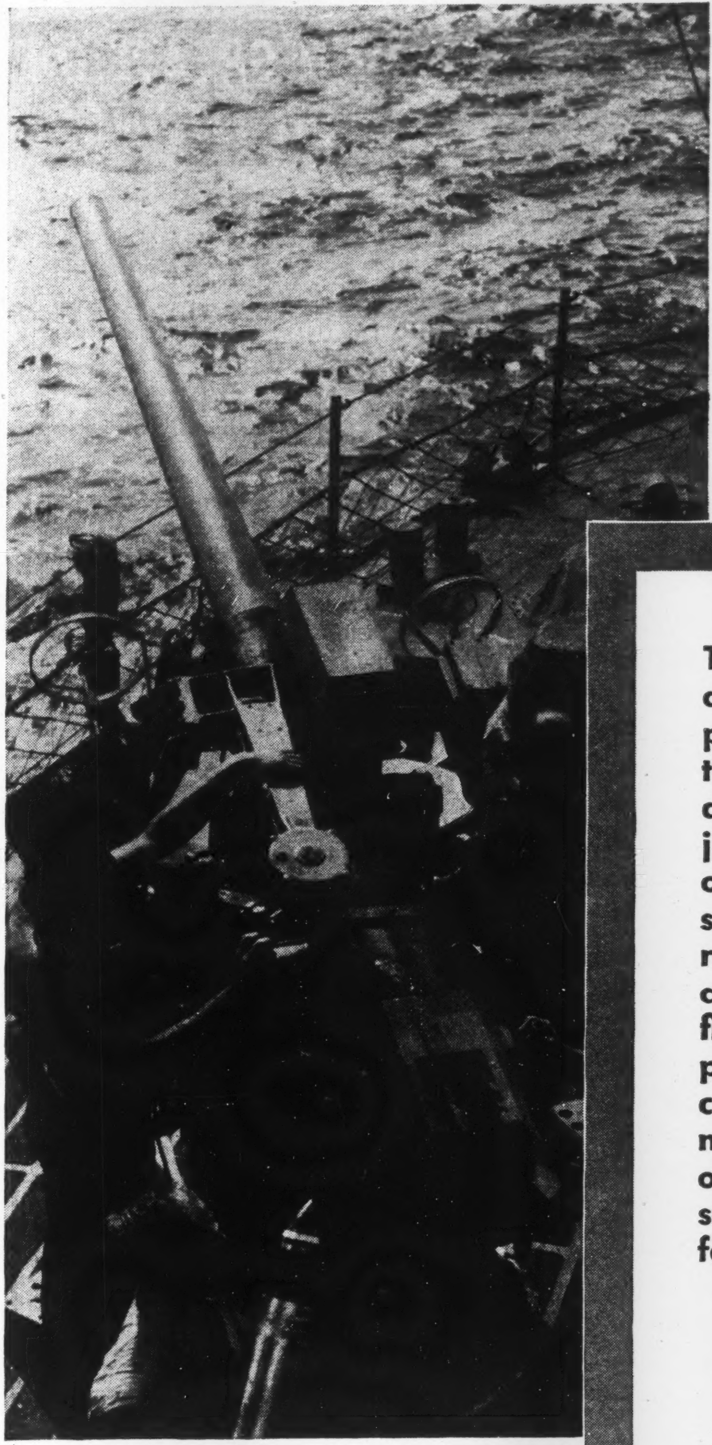
WALSH BUILDING • CINCINNATI, OHIO



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GUNS...
AND MEN!

Today's victories of our armed forces are the result of their superior fire power on land and sea . . . and in the air — a superiority attained by design engineers working in conjunction with the army and navy ordnance departments. Victory and success depend on gun calibre and range . . . also its maneuverability and the clock-like precision of the firing mechanism . . . . D.O.James precision-made gears are important controlling factors in attaining the maximum fire power and efficiency of many of the guns now being so successfully used by our armed forces.

Accurately conforming to these design requirements has been an every-day "must" in our organization for over 55 years in the design, engineering and manufacture of all types of gears and gear speed reducers.

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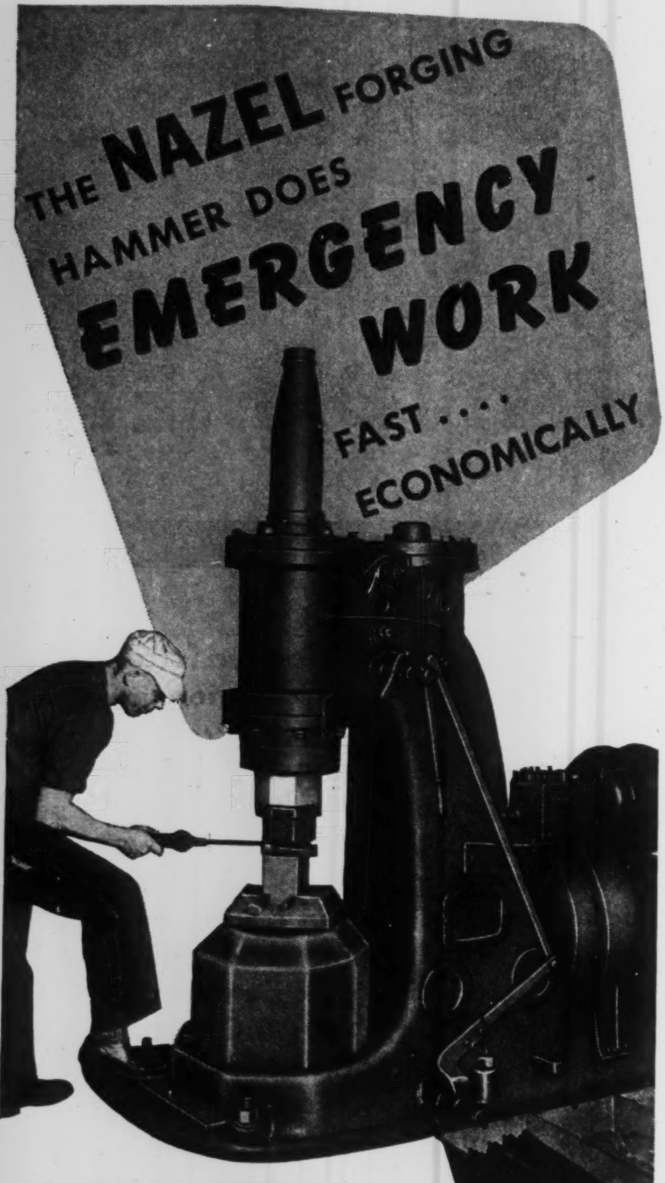

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Independent of the plant's steam supply, the Nazel hammer is ready at the push of a switch to deliver its powerful, clinging, non-bounding blows . . . in perfect response to the will of the operator. And when the job is done and the current cut off, the hammer's power expense ceases.

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NO GREASE OR OIL FITTINGS
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HEAVY-DUTY
AIR-COOLED
ENGINES

In today's war production set-up, even the saving of fractional manpower for servicing grease cups and oil fittings is important. And neglect of this attention can mean serious damage to irreplaceable production equipment. This can't happen with Wisconsin Engines because there are no grease cups or oil fittings; no lost manpower; no chance for human error or carelessness. Wisconsin Engines are protected by positive force-feed and splash lubrication.

MOST POWER Per POUND

WISCONSIN MOTOR Corporation
MILWAUKEE, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

MECHANICAL ENGINEERING

November, 1943 CARD INDEX Vol. 65, No. 11

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Quick steaming, all-welded portable with refractory lined firebox and 2-pass tubes to save fuel. 50 to 150 hp. 125 and 150 lbs. WP.

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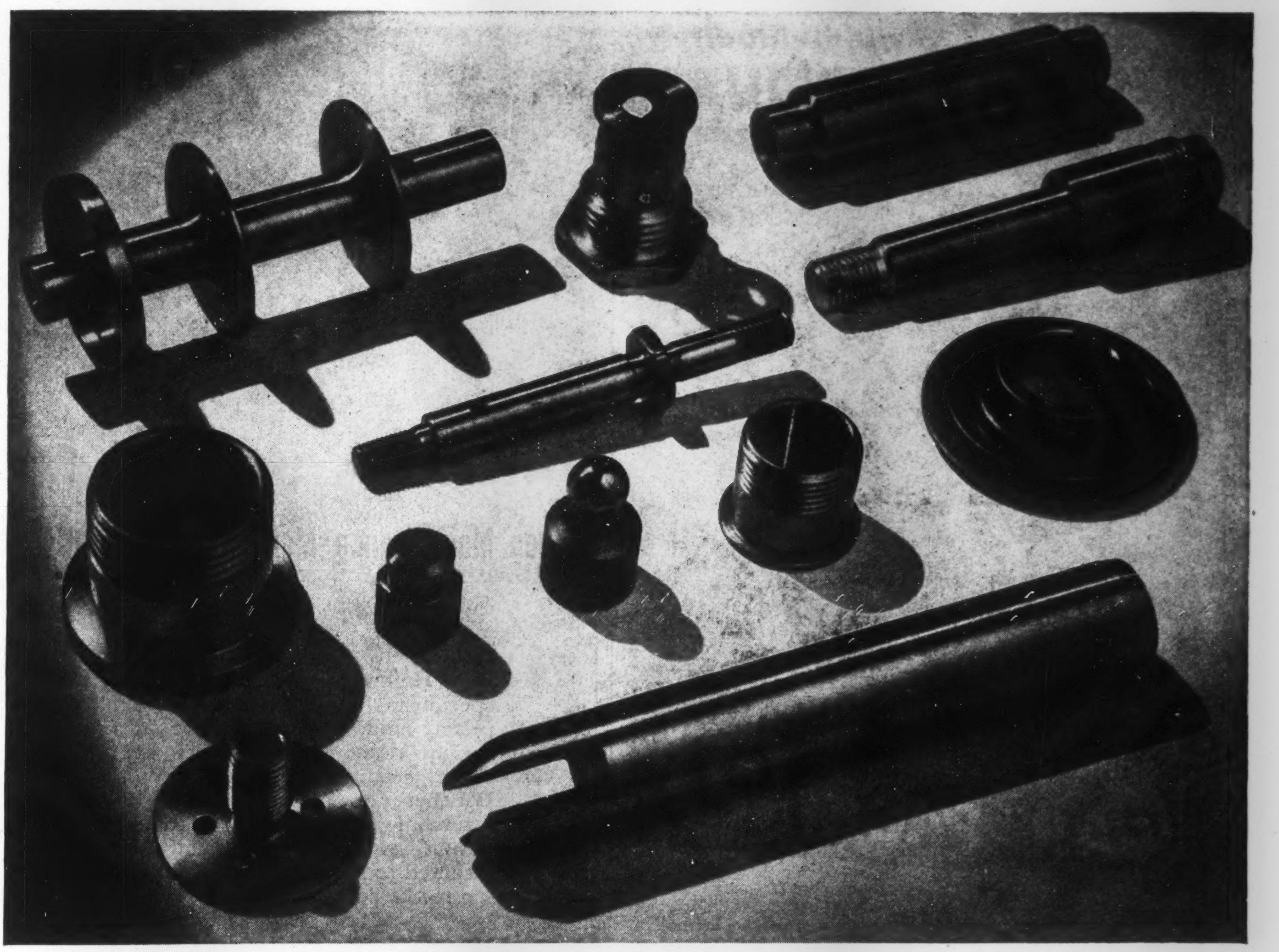

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...More than a Score of Finishing Processes

Nearly twenty years ago **Hartford** was asked to make precision screw machine parts for aircraft engines. There was no precedent, no pattern to follow. Blueprints and specifications didn't tell the complete story; machining and finishing these parts correctly required full understanding of expected performance. Results depended on **Hartford's** trained personnel. That confidence in our men was not misplaced.

Widely experienced, **Hartford** knows how to get the most out of machines in terms of precision production in large quantities. Screw machine capacity, 1/64 in. to 5 in. diameter; cold heading facilities, ¼ in. to ⅝ in. by 4 in. long; wide variety of finishing equipment. Our nearly seventy years of experience in making special screw machine products, are your guarantee that you'll get the parts exactly as you want them at the right price.

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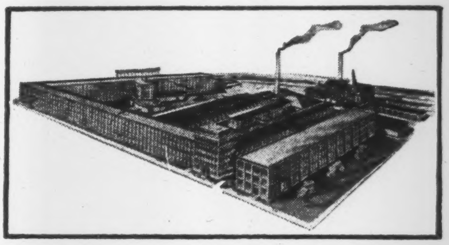

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These two characteristics are essential to the proper functioning of the ring as a seal at both high and low pressures and under all atmospheric conditions . . . and they can be obtained, we believe, *only by individual precision grinding.*

Today, "PAR" Packings are helping to insure the dependable operation of the struts, bomb bays, retracting mechanisms, brakes and other hydraulically controlled parts of the bombers and fighting planes that are hastening the defeat of the Axis. Tomorrow, when military demands relax, these precision-made, long-wearing packings will be available in quantities to manufacturers of hydraulic equipment. Samples and engineering consultation available *now!*

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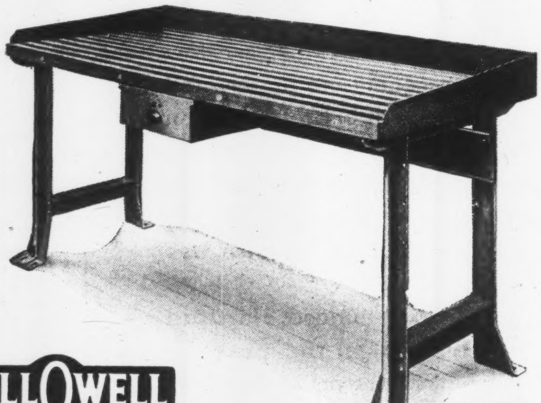

Fig. 928.

HALLOWELL
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"HALLOWELL" WORK-BENCH WITH
TOP OF SMOOTH, LAMINATED WOOD.
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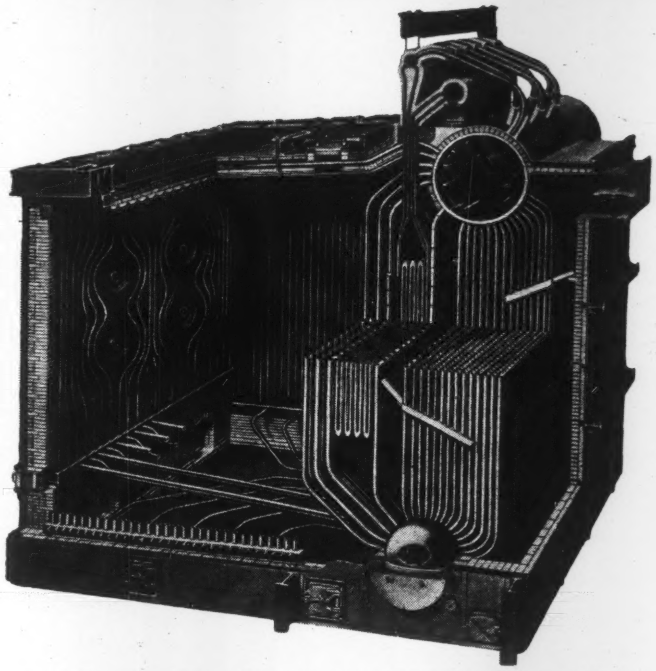


Another Victory Unit speeds war production

Sectional view of a C-E Steam Generator, Type VU, which is the type of unit responsible for the notable performance record described below.

Here's the most recent VU Steam Generator to prove the aptness of its wartime name – Victory Unit*. In a large Canadian aluminum plant, which is operating at full speed to produce increased quantities of its vital product, this VU Unit was first placed in service during March 1942. It was taken off the line for its *first* inspection in December 1942 *after 9 months of continuous operation.*

During this entire period the Victory Unit, designed for 131,000 lb maximum continuous output, generated an average of 120,000 lb of steam per hr. The peak load was 155,000 lb of steam per hr which was sustained for relatively long periods as is indicated by *average daily outputs* as high as 133,000 lb of steam per hr.

The inherent quality of the VU Unit is demonstrated by the report of the company on the findings of the first inspection. The boiler was in exceptionally good condition. Drum, tubes and headers were free of scale and very clean except for a slight sludge deposit which was easily washed out.

The furnace, boiler passes and preheater were so clean that they required but little attention. Except for repacking of valves and the normal replacement of those mill parts subjected to severe wear, no repairs were necessary.

Thus the design features of the VU Steam Generator and the quality of its construction help once again to minimize "time out" for inspection and maintenance so that the production of a vital war commodity may continue apace. Hence the appropriateness of the wartime name – Victory Unit.

A-727-A

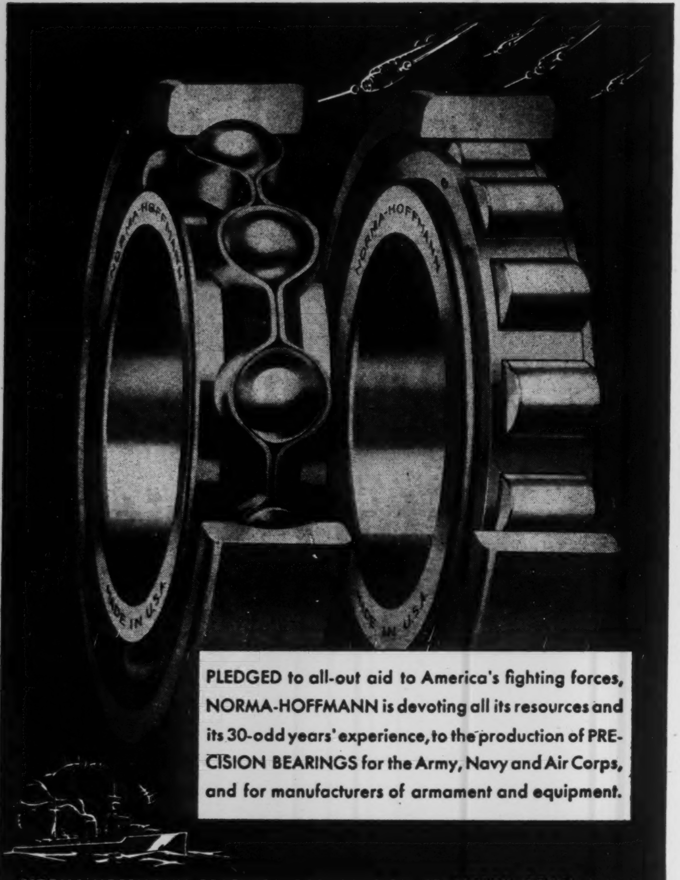
*Labelled The Victory Unit many months ago by a member of our Engineering Department who was impressed by the number of these units going into war plants.

C-E

COMBUSTION ENGINEERING

200 MADISON AVENUE, NEW YORK 16, N. Y.

Canadian Associates: **COMBUSTION ENGINEERING CORPORATION LIMITED** • Montreal • Toronto • Winnipeg • Vancouver



PLEDGED to all-out aid to America's fighting forces, **NORMA-HOFFMANN** is devoting all its resources and its 30-odd years' experience, to the production of **PRECISION BEARINGS** for the Army, Navy and Air Corps, and for manufacturers of armament and equipment.

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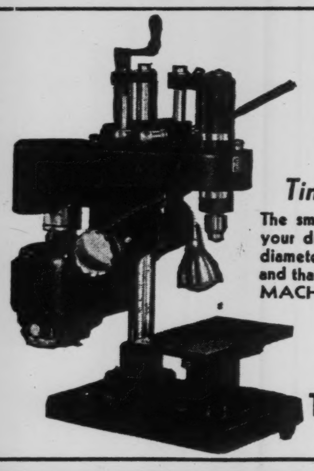
BALL, ROLLER AND THRUST BEARINGS · FOUNDED 191[illegible]



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DRILLING MACHINE

Tiny Holes Loom Important

The smaller, the more precision you need in your drilling. Holes from .004 to .250" in diameter require extraordinary perfection . . . and that's what the HAMILTON DRILLING MACHINE supplies.

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SAVE ON SMALL DRILLS

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No delay waiting for dies—parts ready quicker—deliveries speeded up. Women are rapidly taking a major place on the industrial front. DI-ACRO Precision Machines—Shears, Brakes, Benders—are ideally suited for use by women in making duplicated parts accurate to .001"—
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DUPLICATING.

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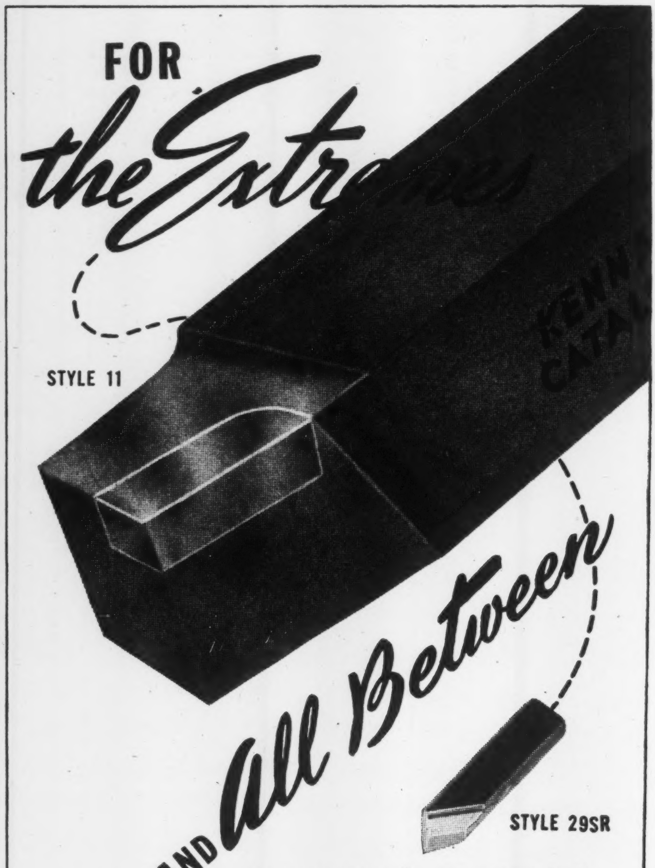


. . . AND *All Between*

KENNAMETAL

★ Here illustrated are two machining tools—one large, the other small, but each is a *great* tool—Kennametal. The cutting edge for the large one is ground on a tip of carbide brazed to the steel shank, that for the small one is ground on a solid round piece of carbide. Each is just as keen as the other for its specific purpose, each equally distinguished for superior performance on jobs within its scope of application. The large tool is for rough turning, the small tool for precision boring.

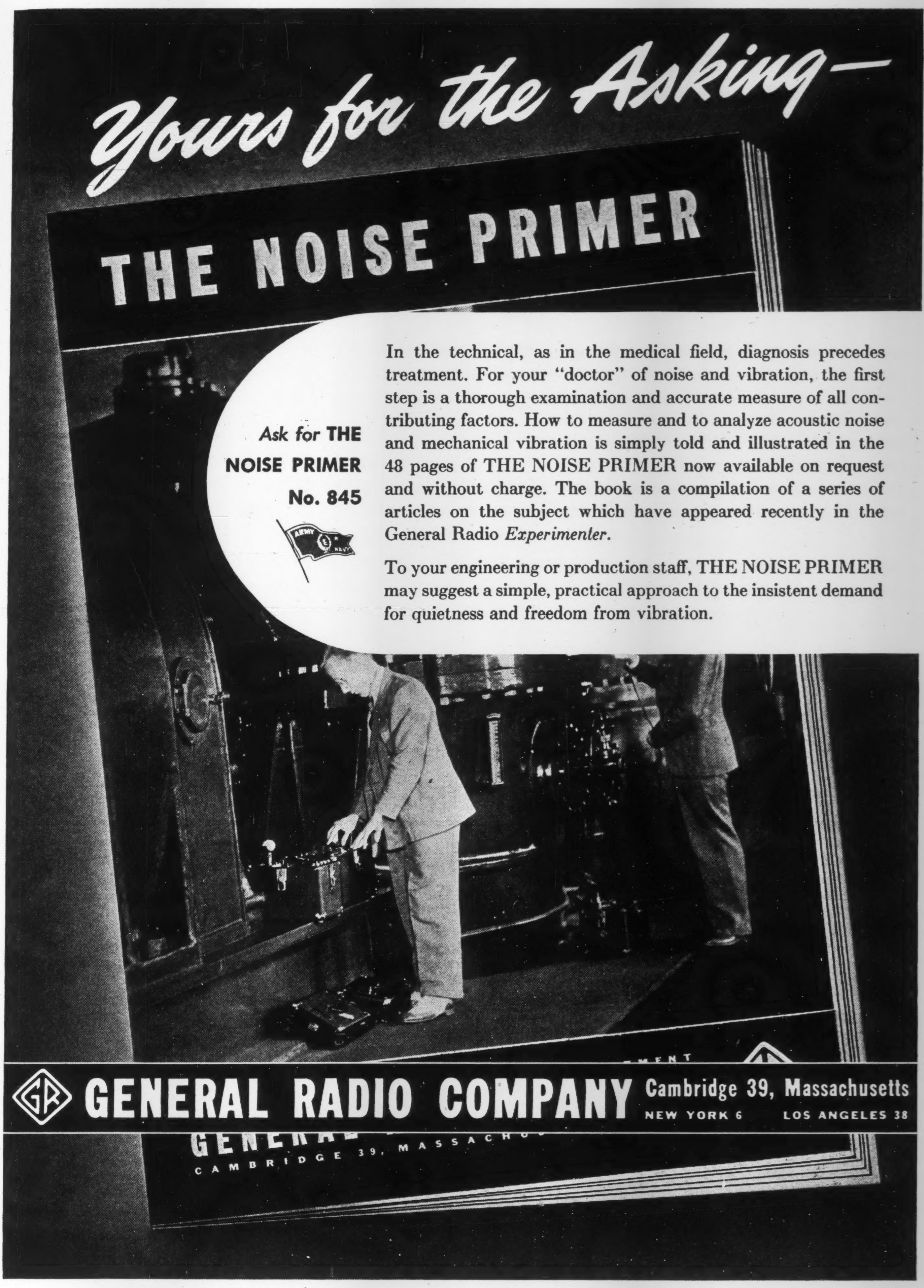
Here are two extremes in size and purpose, but in between is an array of Kennametal tools suitable for a wide variety of uses—thirty or more different styles, many sizes in each, five available grades of carbide in varying degrees of hardness. Every Kennametal tool, when fitted to its specific job, and correctly used, makes a distinctive contribution to the metal working industry. Maximum machining production, superior finish, accuracy to close tolerances, enduring service—these are outstanding characteristics.

Our new Catalog 43C gives information for selecting, ordering, and maintaining the wide variety of Kennametal tools. Do you have a copy? If so, are you making full use of it?

KENNAMETAL THE *All American* CARBIDE

KENNAMETAL *Inc.*
367 Lloyd Ave., Latrobe, Pa.

Trade Mark Reg. U. S. Pat. Off.



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B-G-R springs disappear daily into the great war plants of this nation to do the kind of a job for which they are intended. It may be on the firing line—or it may be in the machines that make fighting weapons. It's all the same, every job today is a war job.

For years, B-G-R springs have helped to build reputations for many nationally known products by reliable, trouble-free performance. They work mostly behind the scenes in the mechanisms of our customers. You can't identify a B-G-R spring by just looking. But when it comes to cold analysis of comparative tests in actual use, you'll understand why B-G-R springs are specified year after year. Try them and see for yourself.

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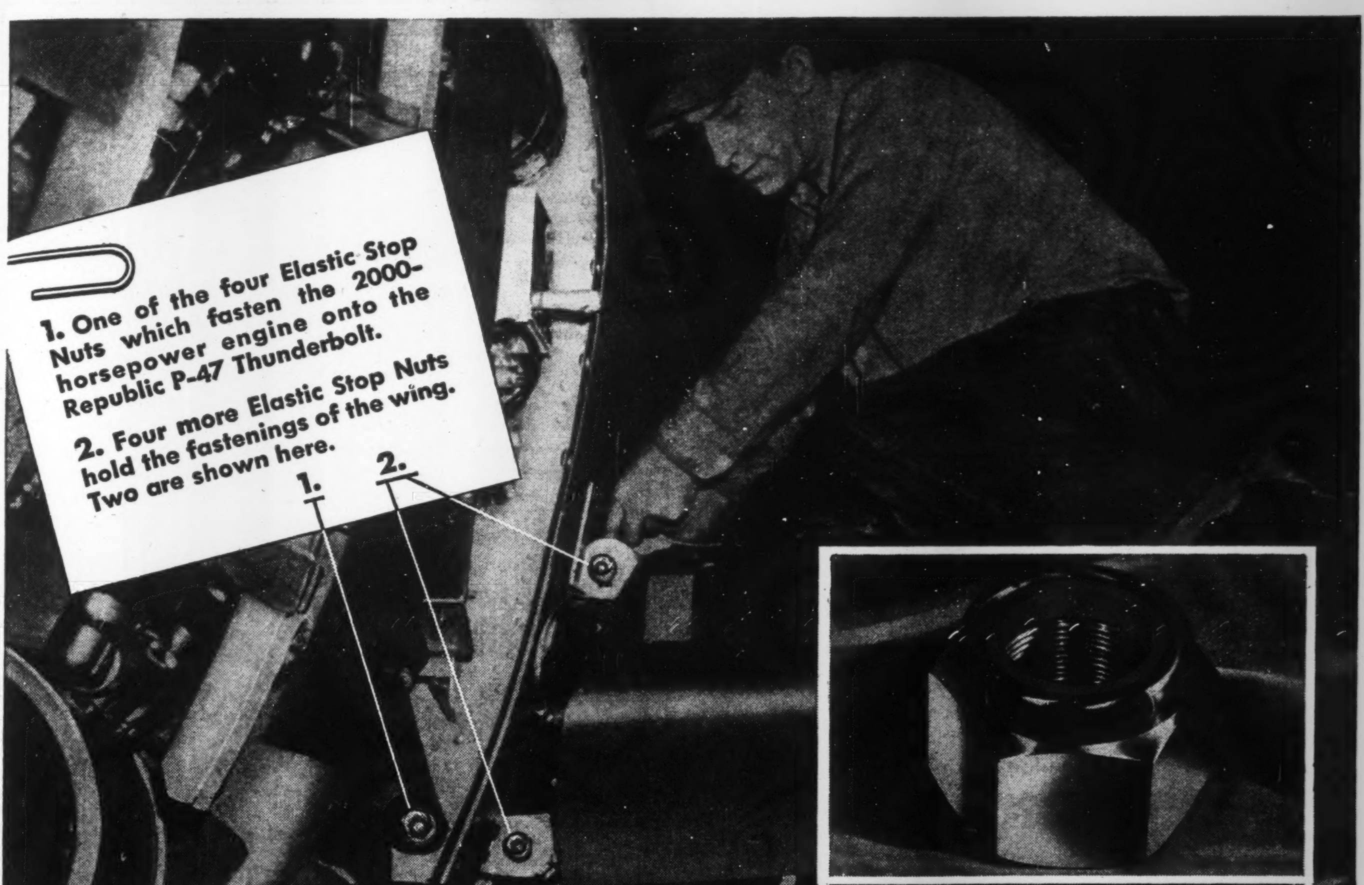
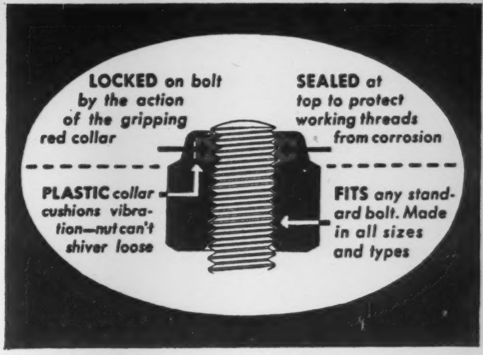

1. One of the four Elastic Stop Nuts which fasten the 2000-horsepower engine onto the Republic P-47 Thunderbolt.
2. Four more Elastic Stop Nuts hold the fastenings of the wing. Two are shown here.
1.
2.


LOCKED on bolt by the action of the gripping red collar
SEALED at top to protect working threads from corrosion
PLASTIC collar cushions vibration—nut can't shiver loose
FITS any standard bolt. Made in all sizes and types

You've gotta hang on when you say "Giddap" to 2,000 horses

When the pilot of a Republic P-47 pours on the soup, 2,000 surging, throbbing horsepower yank him into the high blue heavens.

When he climbs straight up he is literally hanging on his prop and engine.

And those tons of plane, man and armament hold onto that engine with just four Elastic Stop Nuts.

This is the kind of job that has given Elastic Stop Nuts the reputation of having revolutionized modern aircraft construction. It's the reason you find over 12,000 of them on the P-47 and as many as 50,000 on some types of bombers.

It's all because these nuts hold fast — without auxiliary locking devices. They're applied like ordinary nuts. They can be removed and replaced time and again without losing locking effectiveness. They stay put, and nothing, even violent vibration, shakes them loose.

It's done by the red elastic collar in the top. This collar clings tightly around the bolt threads. It absorbs and cushions vibration from every direction. The nut can't shiver loose — can't turn.

Postwar progress will present countless fastening problems which these nuts will solve. Perhaps you already are studying such problems. If so, let us know about them. Our engineers will be very glad to help work out a solution and show you how an Elastic Stop Nut will provide a safer, surer, trouble-free fastening.

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Lock fast to make things last

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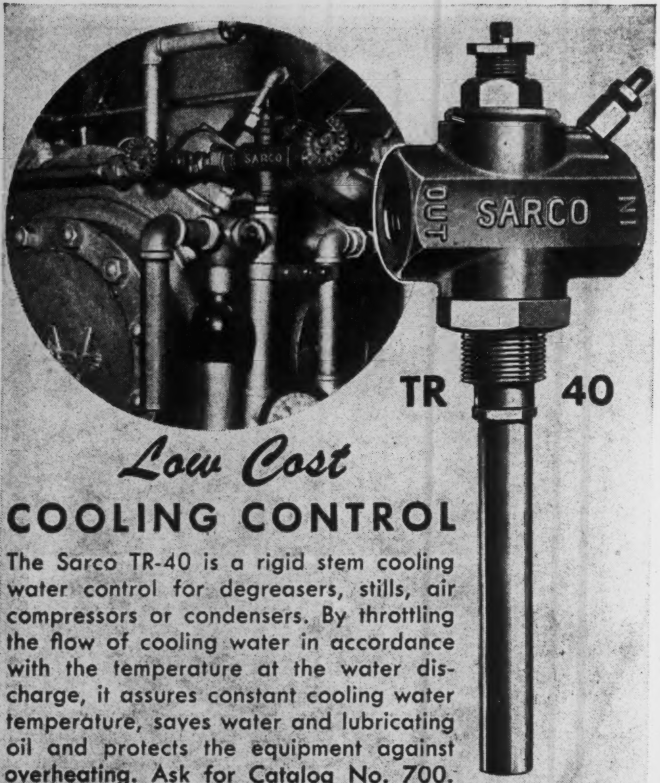
BACK THE ATTACK . . . BUY WAR BONDS

ELASTIC STOP NUT CORPORATION OF AMERICA
UNION, NEW JERSEY AND LINCOLN, NEBRASKA



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SARCO CANADA, LTD., 85 Richmond St. W., TORONTO, ONT.

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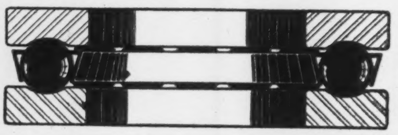

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Standard sizes are shown in our general catalog.

STANDARD SIZES OR SPECIAL DESIGN to your specifications; send sketch or worn sample, regardless of condition, for quotation, without obligation. ● Our complete catalog will help you in making selection of bearings—shall we send it?

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For True Regulation on Boiler Feed Pumps

The Genuine

Squires

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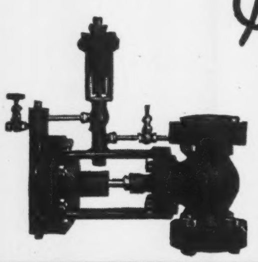

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Cleveland, O.

POWER
100 PER CENT

Question: HOW IS YOUR POWER COUPLED RECEIVING END?

Full power delivery means freedom from misalignment, whip, backlash, instant takeup of surges. Protection requires the *most efficient couplings.*

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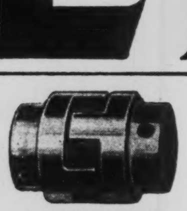
Flexible Couplings

NEVER NEED LUBRICATION

L-R Couplings insure maximum use of your power, greater safeguards for your equipment, dependable power flow for your time-tables of *production*, for reasons that you will find only in L-R. Free floating individual resilient load cushions instantly deform and adjust to any and every emergency. Internal friction is eliminated.



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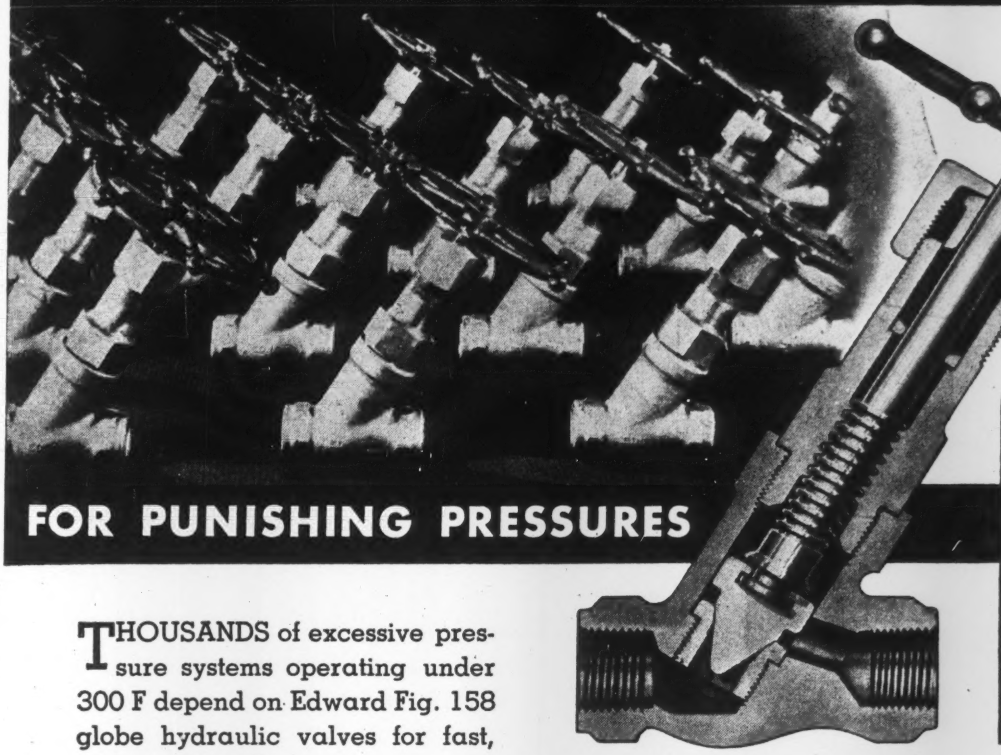
EDWARD 6000 LB HYDRAULIC VALVES



FOR PUNISHING PRESSURES

FIG. 158 GLOBE

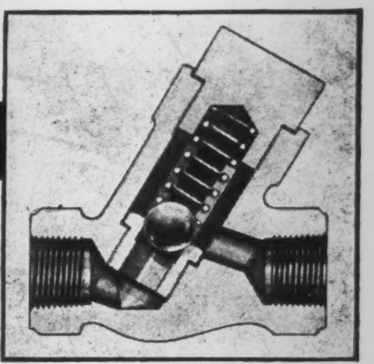
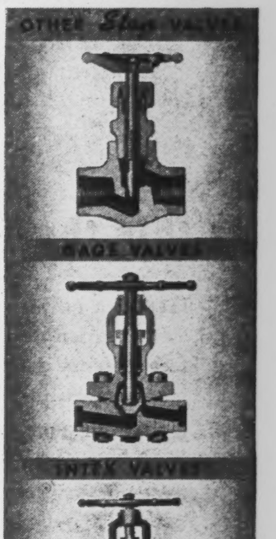


FIG. 160 BALL CHECK VALVE

THOUSANDS of excessive pressure systems operating under 300 F depend on Edward Fig. 158 globe hydraulic valves for fast, certain shut-off or accurate pressure control.

The seat and swivel needle disk are made of EValloy, Edward's own development in abrasion resisting stainless steel. The inside screw construction, the extra deep stuffing box and the special gland and packing nut design lengthen packing life and prevent leakage along the stem. Streamlined body contours permit free flow at high velocities with low pressure drop.

These—and other—specific advantages of Edward Fig. 158 valves add up to savings in maintenance time and replacement parts. For information on valves in the Edward line write for Edward BETTER VALVES Catalog No. 101.



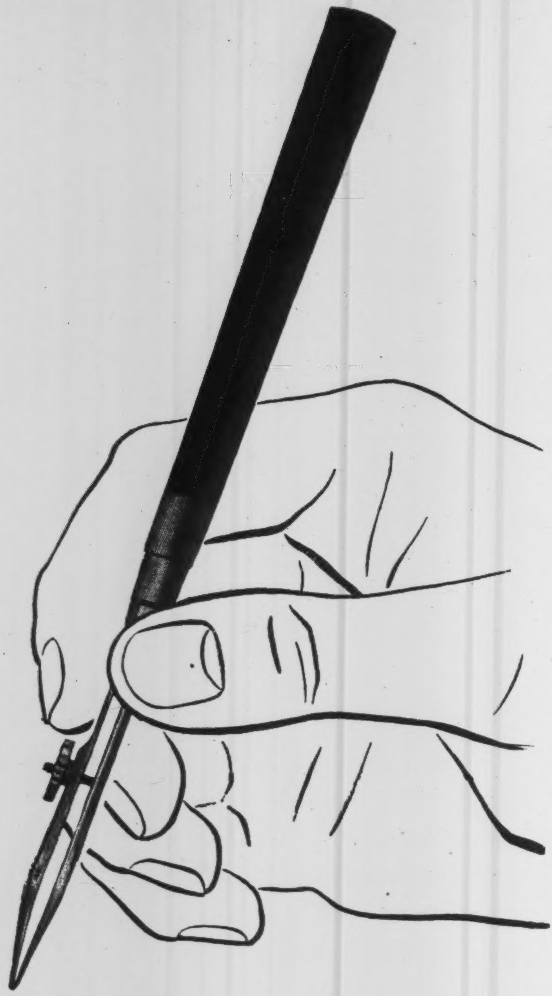
Corresponding ball check valves, Fig. 160, with same ratings, also available.

DIMENSIONAL DETAILS OF EDWARD Fig. 158 and 160 HYDRAULIC VALVES
For power, petroleum, chemical process, marine, technological or general industrial service
Rating 6000 lb at 125 F
Globe type, screwed or socket welding ends

SIZE	¼"	⅜"	½"	¾"	1"	1¼"	1½"	2"
End to End, Fig. 158 and 160	3¾	3¾	3¾	4½	5⅛	6½	7½	9
Center to Top Open, Fig. 158	8¼	8¼	8¼	9¼	10⅞	13¾	14⅞	18
Handwheel Diameter, Fig. 158	5⅜	5⅜	5⅜	6⅜	8½	10⅛	10⅛	11½
Weight—lbs, Fig. 158	3¼	3¼	4¾	7	12	22	37	62
Weight—lbs, Fig. 160	1½	1½	2¾	4½	7¼	13½	19¾	40

THE EDWARD VALVE & MFG. CO., INC., 1350 W. 145th Street
East Chicago, Indiana

EDWARD *Steel* VALVES



Is this the Perfect Ruling Pen?

HERE'S a new ruling pen you will be proud to own—a ruling pen designed by Bruning craftsmen to be perfect in every detail. We believe you will find it different from any ruling pen you have used. Here's why—

BETTER DESIGN. Balanced for proper "feel"—precisely proportioned in point and handle—beautiful in appearance and as useful as it is beautiful—pen shaped to have a natural feel when guided against straight edge.

BETTER MATERIAL. Point made of finest tempered tool steel, properly heat-treated for longer wear—properly drawn for correct tension of upper or spring blade. Natural, polished coco-bola wood handle.

See your Bruning representative now about this new Bruning Ruling Pen—or write us for complete information. Charles Bruning Company, Inc.

2258-327

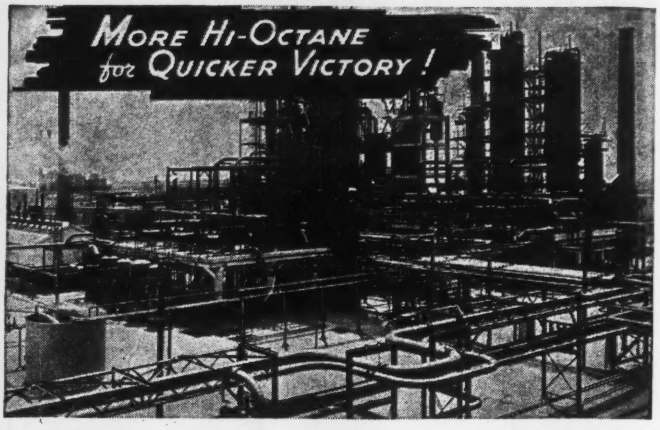
BRUNING

SINCE 1897

NEW YORK • CHICAGO • LOS ANGELES

Branches in 14 Principal Cities

Everything For The Engineer And Draftsman



New Gulf Refining Co. Houdry Unit for production of hi-octane gasoline. Engineers—E. B. Banger & Sons., Boston, Mass.

Carey HEAT INSULATIONS

Help Assure Top Production for GULF'S NEW HOUDRY UNIT

Carey Heat Insulations were specified for this big refining operation, just as they have been chosen for other large units throughout the oil industry—on a basis of known and proved outstanding performance.

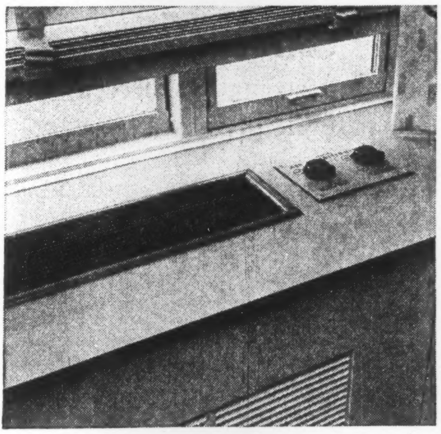
Whatever your particular insulation problems, remember you can depend on CAREY Heat Insulations and our nationwide engineering and distribution service. Write Dept. 63 for details.

THE PHILIP CAREY MFG. COMPANY • Lockland, Cincinnati, Ohio
Dependable Products Since 1873
IN CANADA THE PHILIP CAREY COMPANY LTD. Office and Factory LENNOXVILLE, P. Q.

BUY CHRISTMAS SEALS
PROTECT YOUR HOME FROM
TUBERCULOSIS

WORLD'S LARGEST completely Air Conditioned Hotel opens in Nation's Capital

Heating and Ventilating Contractor: Mehring and Hanson Co., Chicago, Ill. Architect and Consulting Engineer: Holabird and Root, Chicago, Ill. General Contractor: Harris Co., New York.



Every guest room has a Carrier Weathermaster unit with individual control. Positive circulation of outside air is also provided.

New Statler in Washington, First Hotel To Install Carrier Conduit Weathermaster System

• Year round air conditioning of the entire building is an outstanding feature of the new Statler Hotel, most recent addition to Washington's rapidly rising skyline.

Two Carrier Centrifugal Refrigeration Machines provide a daily cooling capacity equal to the melting of 1,100 tons of ice. Individual Carrier Weathermaster units serve conditioned air to each guest room. Lobbies, dining rooms, corridors, and all public spaces are air conditioned from the central plant.

The air conditioning equipment was designed as an integral part of the building thus gaining space equivalent to two extra floors while keeping the height of the structure within building code requirements.

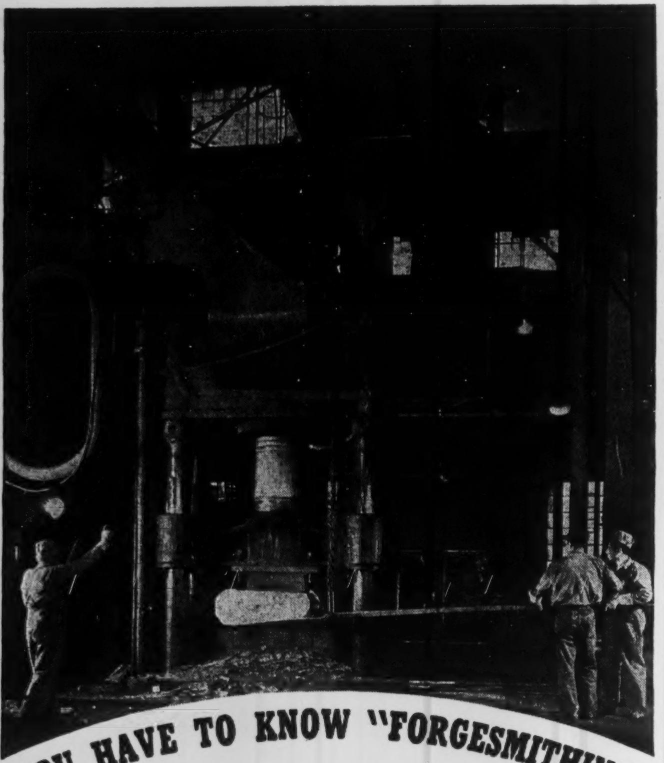
Occupants of guest rooms may dial "Warmer" or "Cooler" as desired. All air delivered to guest rooms is 100% outside air. Heated or chilled water is circulated in Weathermasters. In rooms receiving the full heat of the sun, cooling can be obtained while heating is being used in rooms which have northern exposure.

CARRIER CORPORATION, SYRACUSE, N.Y.

Carrier

ARMY E NAVY

AIR CONDITIONING • REFRIGERATION



YOU HAVE TO KNOW "FORGESMITHING"

TO KNOW STEEL FORGINGS

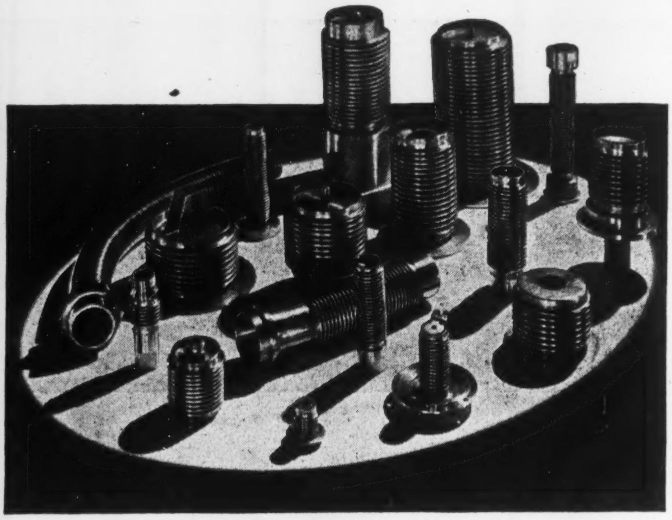
- It's a far step from the village blacksmith's shop to the modern hydraulic press that shapes a thirty ton ingot of alloy steel. But the basic principles successfully used are the same. The forgesmiths must have the necessary facilities and long acquired experience. They must have adequate furnaces equipped with pyrometer controls for properly heating the ingot and an accurate knowledge of how and where to apply the forging pressure.

Correctly controlled heating and application of pressure permits the smiths to forge into the steel a structure of quality. By knowing what it takes to produce a flawless forging, it is easy to understand why the steel forging with heavy duty work to do should be National Forged.

NATIONAL FORGE
& ORDNANCE CO.
IRVINE, WARREN COUNTY, PENNA.
"WE MAKE OUR OWN STEEL"

For Excellence E *in Production*

War Bond Buyers are Guarantors of Victory



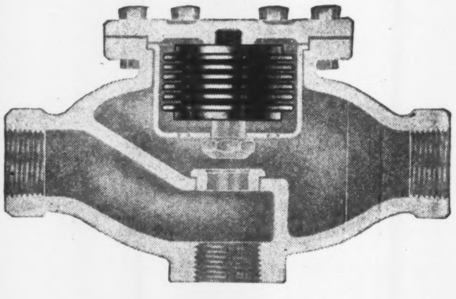
CMH

Stainless Steel Bellows

Wherever stainless steel's corrosion resistant qualities and temperature values are required in bellows service, CMH uni-metal **circular seam welded** assemblies are filling that need.

No Solder or Flux Required

Long lengths of CMH Bellows are standard production; strength is further enhanced with **multiple ply** assemblies when needed.



Ask for engineering recommendations on specific applications.

CHICAGO METAL HOSE CORPORATION
General Offices: MAYWOOD, ILLINOIS
Factories: Maywood and Elgin, Illinois

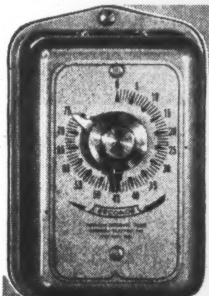
WHAT FLUX is BEST . . .

for welding Silicon Bronzes?
Silver Soldering or Gas Welding Stainless?

Get the answers to these and hundreds of similar questions from the Krembs Fluxine Chart . . . . new, revised edition just published. Explains how to select the proper flux for every metal-joining job. Easy to use. Handy for reference. Prepared by consulting, welding and brazing engineers, originators of 89 different non-bubbling, quick flowing Fluxine Fluxes. Chart free when requested on a company letterhead.

KREMBS AND COMPANY
666 West Ohio Street Chicago 10, Illinois
Chemists and Metallurgists Since 1875.

FLUXINE
TRADE MARK REGISTERED U.S. PAT. OFF.
FLUXES TO JOIN ALL METALS



Available Now
TIME DELAY RELAYS

by Paragon

Used to accurately delay the closing or opening of an electrical circuit following a power failure or disconnect of the A. C. operating potential. Or to provide an adjustable time delay between the closing of a pilot circuit and the subsequent closing or opening of the Timer load circuit. Ideal for automatic protection of electronic tube plate circuits against sudden application of power. Powered by self-starting industrial type synchronous motors.

Hundreds of applications. Each unit precision built—rugged and dependable. Write for complete catalog of time control instruments today.

PARAGON ELECTRIC COMPANY
39 W. Van Buren St. • Chicago, Illinois

Paragon Chicago
BUILDERS OF ELECTRICAL EQUIPMENT . . . . SINCE 1905

AMERICAN PENCIL CO. NEW YORK - VENUS - DRAWING - HB

"OUR CAMOUFLAGE DEPARTMENT"

Camouflage is confusing—particularly when the 2H mark on a drawing pencil camouflages a 3H lead. . . . Draftsmen, architects and engineers want a drawing pencil they can *rely* on. That means that the pencil in any given degree *always* has exactly the same feel and produces exactly the same line. It also means that the lead holds the point you give it—and is uniformly smooth, from first sharpening to final stub.

More draftsmen, architects and engineers use the Venus Drawing Pencil than any other make. They can depend on Venus Drawing—whenever and wherever they buy.

Try Venus Drawing yourself at our expense. Just mail us the coupon below—circling the two degrees you would like to try—and we will gladly send you free samples.

VENUS *Drawing* PENCILS

American Pencil Company
Dept. 185, 500 Willow Ave., Hoboken, N. J.
In Canada: Venus Pencil Company, Ltd., Toronto

Please send FREE samples of the two grades circled:
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NAME and title ____________________

FIRM NAME ____________________

ADDRESS ____________________

CITY ____________________ STATE ____________________

Birth of an idea

The idea of knurling the points of hollow set screws so they would not shake loose was originated by our President, Mr. Hallowell, to meet a need in our own plant.

One of our machinists had been having a great deal of trouble with set screws working loose on a machine, so every few days he had to tighten them up. This he mentioned to our President as he was passing through the shop and Mr. Hallowell, after some thought, suggested that he knurl the points of the screws and see what would happen.

About a month later the machinist was able to report that since the points had been knurled those screws had never worked loose.

We started production of the "Unbrako" Hollow Set Screws with Knurled Points shortly thereafter. Today, of course, they are in demand everywhere.

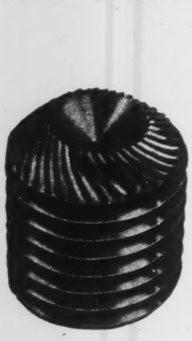
Play safe by specifying and adapting the "UNBRAKO" Knurled Point Locking Screws for all requirements.

Knurling of Socket Screws originated with "Unbrako" years ago.

UNBRAKO

Reg. U S. Pat. Off.

Pat'd.
and
Pat's.
Pending

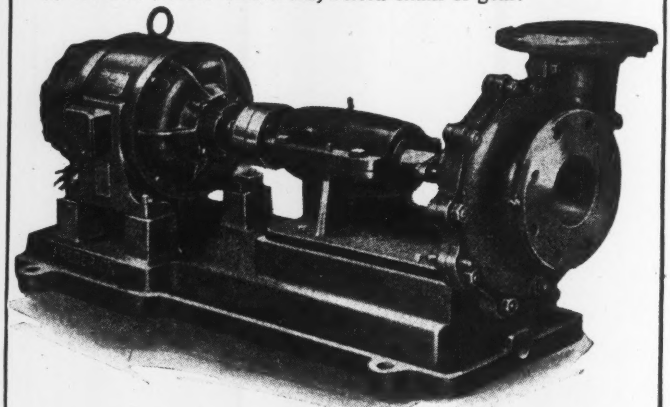


Self-Locking
HOLLOW SET SCREW

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA. BOX 558
—— BRANCHES ——
BOSTON • DETROIT • INDIANAPOLIS • CHICAGO • ST. LOUIS • SAN FRANCISCO
OVER 40 YEARS IN BUSINESS

GUARANTEED TO MEET THE OPERATING CONDITIONS FOR WHICH THEY ARE SOLD!

★ **Types :** Horizontal or vertical; Single suction single and multi-stage; Double suction, single and multi-stage.
★ **Materials:** Stainless steels, acid-resistant bronzes, nickel, lead, or any alloy required.
★ **Drive:** Direct connected, belted chain or gear.



FREDERICK PUMPS

The FREDERICK IRON & STEEL CO.
Frederick, Maryland

The QUESTION BOX:

- How can you humidify 40,000 cu. ft. of space for less than 2¢ an hour?
- Where can you get complete data on humidification by the steam type, unit system?

ARMSTRONG
HUMIDIFIERS

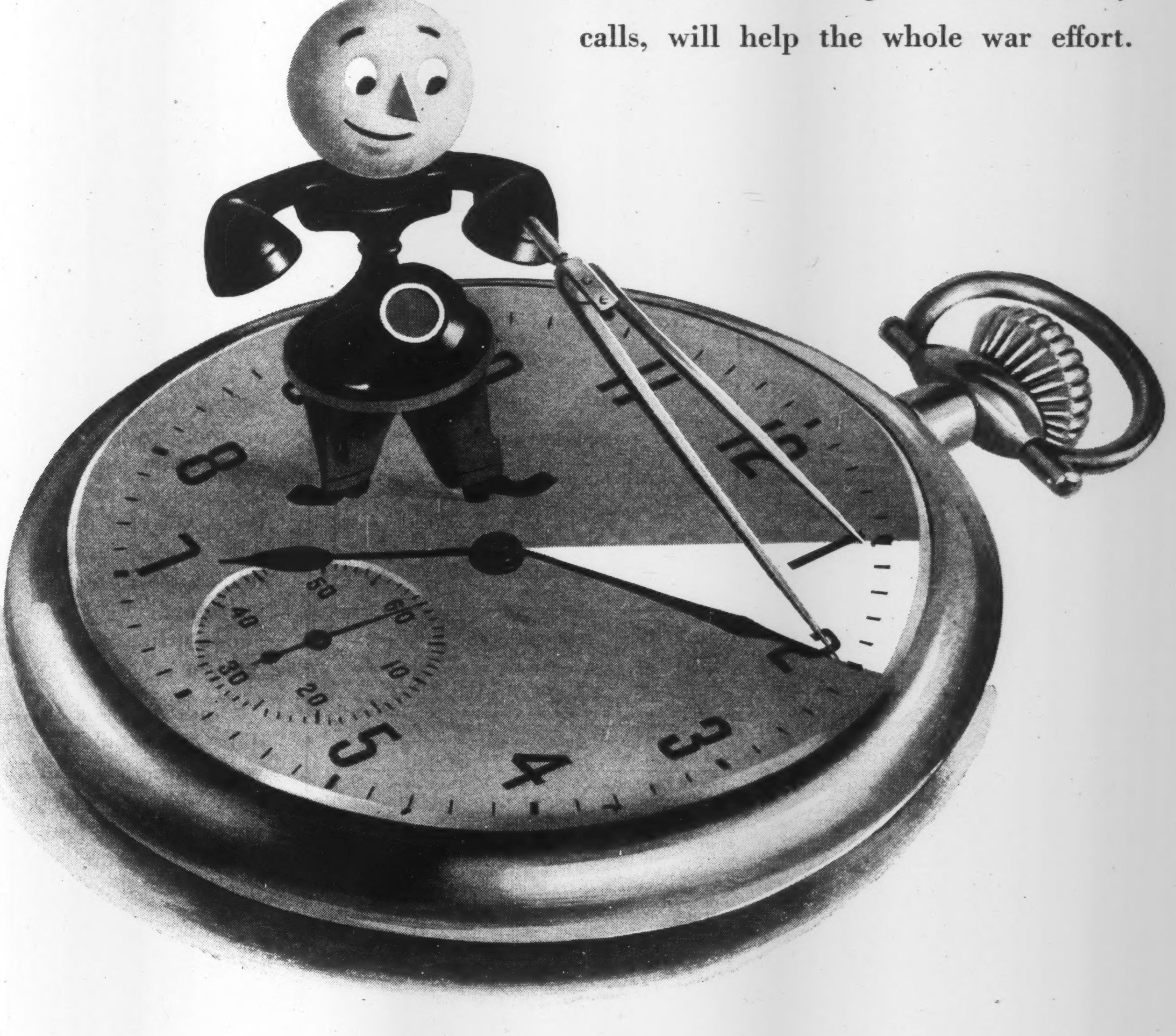
YOU can find the answers to the above and many other questions in the new Armstrong Humidifier Technical Bulletin No. 158 which shows you how to avoid the evils of winter heating dry air, at low cost.

ARMSTRONG MACHINE WORKS
894 Maple Street, Three Rivers, Michigan
YES! I want a copy of your Humidifier Book No. 158 containing valuable information about condensate drainage problems.
NAME ....
COMPANY ....
ADDRESS ....
Please Check: ☐ Plant Engineer ☐ Consulting Engineer
☐ Student Engineer

PLEASE LIMIT YOUR CALL TO FIVE MINUTES

When a Long Distance circuit is crowded the operator will say: "Please limit your call to five minutes."

Observing this time limit on essential calls, and avoiding all unnecessary calls, will help the whole war effort.



BELL TELEPHONE SYSTEM

Representatives—Sales Agencies
Businesses For Sale
Partnership—Capital
Manufacturing Facilities

OPPORTUNITIES

Positions Open—Positions
Wanted—Equipment, Material,
Patents, Books, Instruments,
etc. Wanted and For Sale

POSITIONS OPEN

ENGINEER
INDUSTRIAL DESIGN and DEVELOPMENT

Wanted as assistant to Chief Engineer of long-established, international organization. The right man, with both electrical and mechanical design and engineering experience and demonstrated creative ability in the development of machine products for industry, will command a good salary. This position is with an alert and progressive manufacturer now engaged in vital war work and long recognized as a peacetime leader in its field . . . a leadership which it is determined to hold and which the successful applicant will have a part in holding. You will find working conditions congenial in a pleasant community forty miles from Chicago. Send us your complete background; we will hold it in strictest confidence.

Address CA-851
care of "Mechanical Engineering."

Cracker-jack advertising director, technical graduate, familiar with mechanical equipment used in power plants, refineries, ships. Agency experience helpful. Must be capable and responsible for all advertising details. Location Chicago. Long established and sound firm. Outline experience and education. Live wire, creative, ambitious young engineer, around 35, desired. Address CA-836, care of "Mechanical Engineering."

Chemicals plant in Detroit area wants experienced or recently GRADUATED MECHANICAL ENGINEERS. Also men who expect degrees in the near future. Important defense work. Write giving references, education, experience, and salary desired. Must qualify under WMC regulations. Address CA-837, care of "Mechanical Engineering."

DRAFTSMEN with experience in piping, chemical plant equipment, and general plant layout for work in chemical plant in metropolitan Detroit. Also draftsmen, experience in electrical layout work. Write full details and salary desired. Address CA-838, care of "Mechanical Engineering."

MECHANICAL ENGINEER—who is experienced in design of wire mill machinery and wire insulating equipment, to work in engineering and drafting office of manufacturer of electrical conductors located in New York State. Address CA-849, care of "Mechanical Engineering."

MACHINE DESIGNER—Experienced in the design of special machinery and machine tools. This is an excellent opportunity for a first class man interested in a steady position. Only a man 35–55 with a record of successful achievement will be considered. In replying furnish complete information preliminary to a conveniently arranged interview. Address F. J. Stokes Machine Co., Olney P. O., Philadelphia, Pa.

EQUIPMENT SUPERINTENDENT capable of taking charge of the maintenance of approximately $180,000.00 worth of construction equipment. Man selected must be able to supervise mechanics, keep records and have a good knowledge of construction equipment. Position permanent if man choosen is satisfactory. Ingham County Road Commission, Mason, Michigan.

WANTED

MECHANICAL ENGINEER

for development work with a small company located in a small town in Western New York. Permanent place for the right man—on war work now, with post-war work waiting.

Address CA-852,
care of "Mechanical Engineering."

DEVELOPMENT AND EXPERIMENTAL ENGINEER

Experienced Mechanical Engineer, machine designer of an inventive type, to organize a Machine Development Department. This is not a temporary position but a long time proposition with a high grade well-established company of some 8,000 employees, and a leader in its particular field.

Address CA-844
care of "Mechanical Engineering."

MECHANICAL OR HYDRAULIC DESIGN ENGINEERS by prominent Ohio client, manufacturing centrifugal pumps and other machinery. There are several openings with excellent post war possibilities. One opening requires only machinery or machine tool design experience, another hydraulic experience as applied to machine tools and the third centrifugal pump experience in the design of mixed flow, axial flow and Francis impellers and cases All applicants must conform to War Manpower rules. Perrin-Paus Co., 8 South Michigan Ave., Chicago.

WE ARE LOOKING FOR A FEW MEN—There *are* only a few of the sort we want. Engineers with a solid background in mechanical design . . . men who aren't hidebound in their thinking. We offer them an unlimited *future* in a new scientific industry now working 100% on military devices. They will help us explore even further the peacetime possibilities of Opti-onics. It's a big job . . . for big men. If we're talking to you, write us your *whole* story. Enclose a photo. Please don't phone or call until an appointment is set up. Chairman, Opti-onics Development, Bell & Howell, 7100 McCormick Road, Chicago 45, Illinois.

RATES Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of 70 cents a line. 60 cents a line to members of A.S.M.E. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display matter carried in single column units of multiples of one inch at flat rate of $10 per inch per insertion. Copy must be on hand not later than the 10th of the month preceding date of publication.

ENGINEERING OPPORTUNITY IN INDUSTRY WITH EXCELLENT POSTWAR OUTLOOK

After the war, one industry that will continue moving forward is air transportation. Here is an outstanding opportunity for engineers to *grow* with the nation's leading domestic airline!

As a member of American Airlines' engineering staff at La Guardia Field in New York, you will be contributing to the war effort—and will also be preparing yourself for an engineering future in aviation.

No aeronautical experience is needed. If you have had at least two years of experience in the design or servicing of tools, machines or mechanical devices in mechanical, electrical or aeronautical fields, you can qualify. Candidates accepted will be given full course in aircraft familiarization. Length of course and starting salary depend on your experience.

Don't overlook this splendid opportunity. Today, write American Airlines at the address below, giving past experience and detailed personal information, including draft status.

AMERICAN AIRLINES, INC.
Personnel Dept., Section "B"
100 East 42nd St., New York 17, N. Y.

Representatives—Sales Agencies
Businesses For Sale
Partnership—Capital
Manufacturing Facilities

OPPORTUNITIES

Positions Open—Positions Wanted—Equipment, Material, Patents, Books, Instruments, etc. Wanted and For Sale

WANTED for the PHILCO ENGINEERING STAFF

- **RADIO—ELECTRONICS—ELECTRICAL ENGINEERS**
  Men with degrees in electrical engineering or comparable experience in radio and television.
- **MECHANICAL ENGINEERS**
  Men with college degrees or comparable experience in the engineering aspects of electrical appliances, and in designing small machinery.
- **DESIGN ENGINEERS—DRAFTSMEN**
  Men with experience in mechanical designing, especially of small metal parts and of the automatic machinery to mass-produce them.
- **PRODUCTION ENGINEERS**
  Including electrical and mechanical engineers familiar with any phase of radio, radio-phonograph and television production.
- **PHYSICISTS**
  Must have science degree in physics. Some practical experience in radio is desirable.

WE expect the men who qualify for these positions to become permanent members of our staff and take an important part in our postwar program.

To maintain the Philco tradition of progressive research and development, is first and foremost in our minds. We provide the finest of technical equipment. But often, even more helpful is the inspiration and personal assistance of working with men who have done so much for the advancement of Radio, Television, Refrigeration and Air-Conditioning.

WRITE US TODAY

Qualified men not now engaged in work requiring their full talents, are invited to write us in detail as to their experience, education, family and draft status, and salary. Letters will be treated in strict confidence.

Hiring subject to local W.M.C. rulings

WRITE TO MR. GEORGE DALE

PHILCO CORPORATION
Philadelphia 34, Penna.

WANTED—A MECHANICAL ENGINEER with product development experience in design and engineering. One who has not only proven his ability to write effectively on technical subjects but who understands the techniques of the printed page. For such a man, 30–35, now planning his postwar years, a leading business paper has an editorial staff opening to offer. Address CA-834 in care of "Mechanical Engineering."

MECHANICAL ENGINEER—25 to 45 years of age. Preference given man experienced in process equipment work. Position permanent and offered by nationally known company. Location Midwest. Address CA-832, care of "Mechanical Engineering."

CHIEF ENGINEER—with considerable experience in the design of centrifugal pumping equipment from standpoints of development of hydraulic efficiency and economical standardized structural design. Should have executive and general mechanical ability. This is a permanent position with a well-established pump and mechanical equipment company located in Chicago. Company engaged in 100% war work on regular peace-time products and is programing a long-term development program on pumping equipment as well as new lines. State availability, qualifications, and salary desired in your reply. Address CA-830, care of "Mechanical Engineering."

MACHINE DESIGNER—Experienced on the design of special machinery and machine tools. This is an excellent opportunity for a first class man interested in a steady position in New England. Only men 35–55 with a record of successful achievements will be considered. In replying furnish complete information preliminary to a conveniently arranged interview. Address CA-788, care of "Mechanical Engineering."

REPRESENTATIVES AVAILABLE

MANUFACTURERS REPRESENTATIVE

Mechanical engineer with wide experience in the sale, manufacture and operation of medium and heavy machinery having extensive acquaintance with purchasing, engineering and maintenance department of large manufacturers, would like to contact machinery manufacturer desirous of obtaining high grade energetic representation in the Pittsburgh district.

Address CA-843,
care of "Mechanical Engineering."

TECHNICAL SALES

Engineering sales office experienced handling and negotiating with engineering departments and Consulting Engineers invites confidential correspondence leading to responsible representation of equipment or machinery manufacturer for the New York metropolitan area. Commission basis desired or other basis considered for account requiring sales to general industrial manufacturing plants and/or power plants. Address CA-845, care of "Mechanical Engineering."

EMPLOYMENT AGENCIES AND SERVICE BUREAUS

EXECUTIVES, ENGINEERS, DESIGNERS, METALLURGISTS needed for Cleveland area. Good salaries. No fee until placed. Write immediately to Bradley Placement Service, 555 Leader Building, Cleveland, Ohio.

SALARIED POSITIONS—$2,500 to $25,000. This advertising service of 33 years' recognized standing negotiates for positions of calibre indicated. Procedure individualized to your personal requirements. Retaining fee protected by refund provision. Identity covered. If salary has been $2,500 or more send for details. R. W. Bixby, Inc., 115 Delward Bldg., Buffalo, N. Y.

E. G. Stroud, Member A.S.M.E., President The Cleveland Engineering Agency Co., 219 Huron-Ninth Building, Cleveland, Ohio, has for 30 years been engaged in technical placement work. Employers wishing to engage Executives, Engineers, Designers, Draftsmen or other technical men are invited to use this service. Applicants available should write for blank and list of opportunities.

POSITIONS WANTED

CHIEF ENGINEER—Centrifugal pumps. Experienced all Engineering and Manufacturing branches. Modern, efficient, economical standardized or special design. All types. Existing lines modernized. Executive many years. Eastern location preferred. Address CA-842, care of "Mechanical Engineering."

MECHANICAL ENGINEER B.S. recognized university. Seeks responsible position. Aeronautical experience since 1939; also in plastics development since 1942. At present not employed at highest skill. Age 24, married, draft deferred. Address CA-846, care of "Mechanical Engineering."

EQUIPMENT FOR SALE

MOTOR-GENERATOR EXCITER—General Electric direct current generator #661083, Compound wound, Form A, Type RC-15, Volts no load—125, Amp.—400, Volts full load—125, Speed—1200/1165, 50 KW. General Electric Three Phase Induction Motor #1187975, Type KT, 347-6-75-1220, Form B, Three Phase, Cycles 60, Speed full load—1165, volts 440, Amp.—89, H.P.—75. Address: Hiram Walker & Sons, Inc., Purchasing Dept., Peoria, Illinois.

FOR SALE—Two-stage, direct gas driven air compressors—Bessemer 80 h.p. Type 9B, $1,500; Clark Bros. 100 h.p. Type S, $1,000; 2 Pattin Bros. 90 h.p. Ekonomy Type, $1,500; Ingersoll-Rand 80 h.p. Type 10, belt-driven, two-stage compressor, $800. All in good condition. Dean Bros., W. T. Waggoner Bldg., Fort Worth 2, Texas.

BUSINESS OPPORTUNITIES

WANTED
IDEAS, INVENTIONS or PATENTS

A company with a nationally known product would like to consider ideas and inventions suitable for post-war use in the industrial and commercial field of applying and dispensing lubricants, such as pumps, point to point, centralized lubrication, etc. Also hydraulic, vacuum, or pneumatic actuated mechanisms, pistons, valves, etc., as used in the Aircraft and Automotive field. Also passenger and industrial elevators, automatic leveling devices, controls, etc., and similar items such as portable lifting and stacking trucks or mechanisms used about factories, etc.

★ ★ ★

Before sending us any information, please write for detailed instructions, Dept. NP3, L. W. Ramsey Advertising Agency, Davenport, Iowa.

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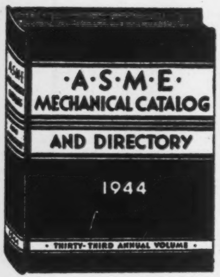
The Only Reference Annual Covering the Mechanical Engineering Field with a Unique Combination of Complete Equipment Directory and Uniform Manufacturers' Catalogs. 16-page Insert Catalog of A. S. M. E. Publications is included.



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Steel Improvement & Forge Co.
Stewart, F. W., Mfg. Corp.
*Taylor Instrument Cos.
*Westinghouse Air Brake Co.
Wiley, John & Sons
*Williams Gauge Co.
*Wing, L. J., Mfg. Co.
Wood's, T. B., Sons Co.

Back the Attack
Buy War Bonds

PRODUCTION
OCT.
NOV.
DEC.
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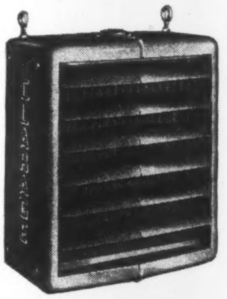
So Unnecessary

to let your production slip this winter . . .

BECAUSE OF POOR HEATING!



CLARCO (PROPELLER FAN TYPE) UNIT HEATERS—ideal for heating any small factory area. Easily installed in any idle space—at any level. Fan designed to deliver maximum of heated air with minimum power. Heating coil equipped with lead coated heavy gauge steel tubes. Also suitable for offices—very quiet in operation.

UNITHERM UNIT HEATERS—designed for wide area heating. Built for floor installation as shown, or for location along side walls or at ceiling. Equipped with centrifugal fans—one for each outlet. Fans mounted on single shaft turning on ball bearings. Heating coil good for pressures up to 200 lbs. Working parts accessible. Outlets adjustable for 4 different directions of heat flow.

INVEST IN VICTORY:
Buy More War Bonds!

Don't let absenteeism, due to colds and other winter ailments, and time losses and spoilage, due to numb fingers, cripple your vital production schedules during the cold months ahead.

★ *Make sure of comfortable temperatures throughout your plant by putting in modern equipment such as Clarage Unit Heaters.*

★ Whether you have an entire plant to heat, or require a few units to help out a present system, the ease with which Clarage Unit Heaters can be installed and their higher heating efficiency should make them your first choice.

★ Clarage has pioneered many improvements. All are incorporated in our present line of heaters. Syncrotherm Control (patented), to mention but one, is tremendously important. It enables you to maintain UNIFORM temperatures. No cold floors; no heat wastage at ceiling! Fuel costs are drastically reduced.

★ *Look into the many advantages of Clarage Unit Heaters NOW! 24 standard sizes, operating on steam or hot water . . . very prompt deliveries. No obligation to have Clarage engineers submit complete recommendation—write, or phone us today!*

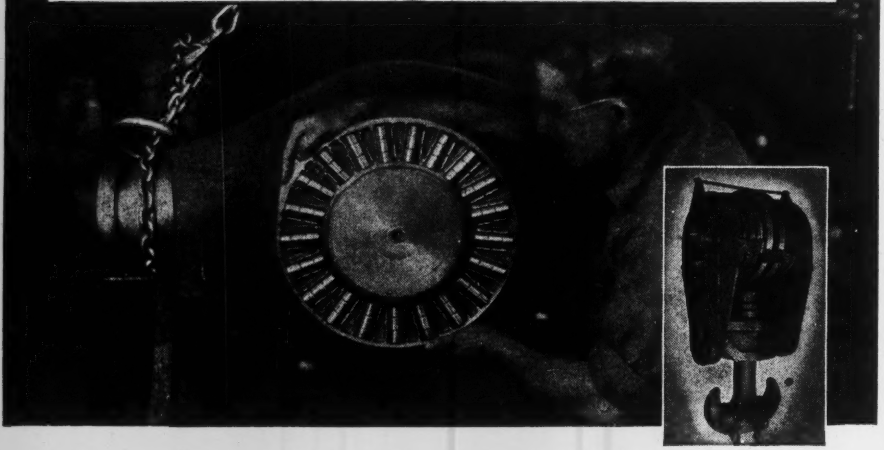
★ ★ ★

COMPLETE AIR CONDITIONING
•
COOLING
•
VENTILATION
•
FACTORY HEATING
•
MECHANICAL DRAFT
•
FANS and BLOWERS for INDUSTRIAL NEEDS

Clarage Fan Company Kalamazoo, Mich.

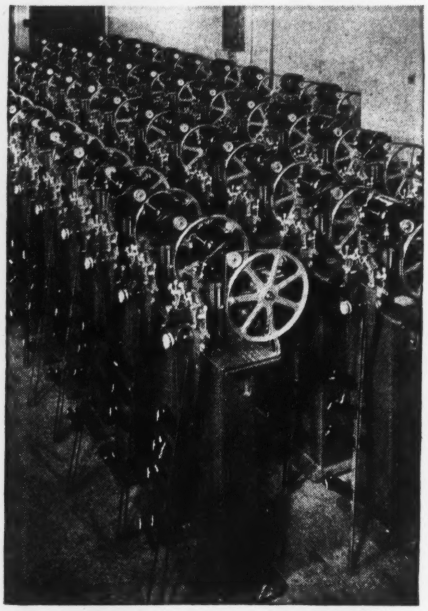
APPLICATION ENGINEERING OFFICES IN ALL PRINCIPAL CITIES

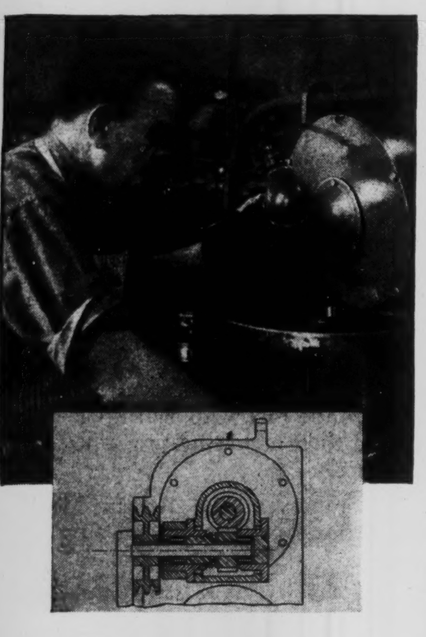
IN THE NEWS
WITH TORRINGTON—BANTAM



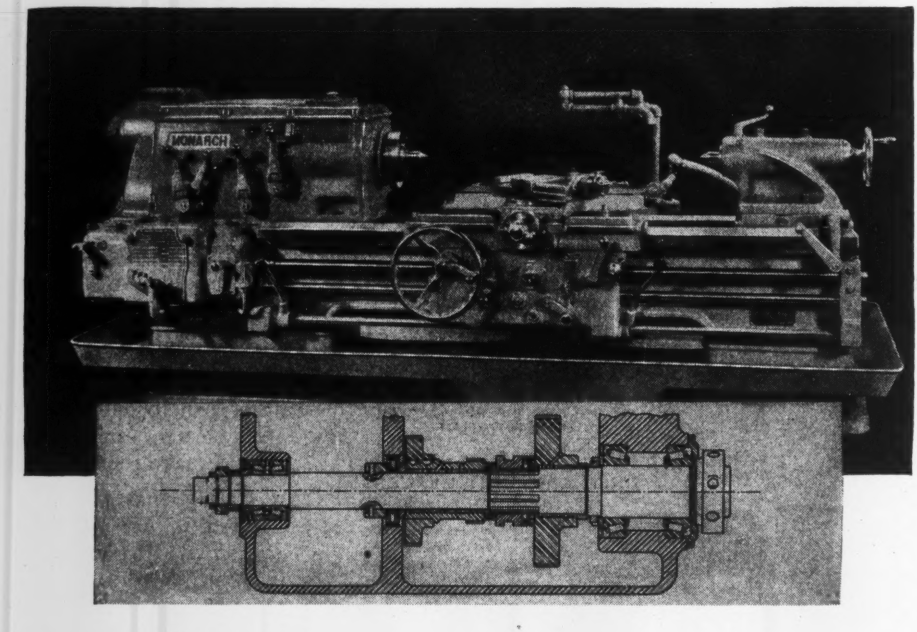
A LARGE PRECISELY CONSTRUCTED ROLLER THRUST BEARING, measuring over a foot in diameter, enables the giant 5½-ton hook, shown in the inset, to rotate smoothly and safely, even when encumbered by its 150-ton capacity load. When the Shepard Niles Crane and Hoist Corporation custom-designed this load block, which is to hang from an overhead electric traveling crane in a West Coast shipyard, they selected a Type LR-71 Roller Thrust Bearing for the yoke bearing because of its compact design which provides a static capacity of 155 tons. This is an excellent example of Torrington's ability to design and build bearings for unusual applications.

FILING SAW TEETH on hand, band and circular saws for the Army Air Corps is the destiny of these Automatic Saw Filers built by the Foley Manufacturing Company. The precise action needed to obtain accurate file cuts depends to a large extent upon the use of compact, high capacity NCS Needle Bearings.





GRINDING OF GEARS, WASHERS and rolls is done rapidly and accurately with this Rotary Surface Grinder made by the Arter Grinding Machine Company. In the four-speed change gear mechanism for the drive to the magnetic chuck, the makers have specified Type NCS Bearings with their compact design and high load capacity. Bearing application is shown in the accompanying cross-section.



NEW STANDARDS OF ACCURACY and performance in metal turning have been developed through the generous use of anti-friction bearings in this Model "M" 16-Speed Engine Lathe built by The Monarch Machine Tool Company. Giving high capacity in a minimum of space, Torrington Radial Roller Bearings have been used as the center support of the spindles of these lathes, as shown graphically in the accompanying cross-section.

BECAUSE OF THEIR LIGHT WEIGHT, low coefficient of friction and high lubricant capacity Needle Bearings serve a wide variety of special applications. If you have a seemingly difficult bearing problem, it may be solved quickly and easily by reference to Torrington-Bantam's complete line of Needle Bearings of all types and sizes. Whatever your bearing problem, TURN TO TORRINGTON for expert engineering counsel.

ARMY E NAVY

TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

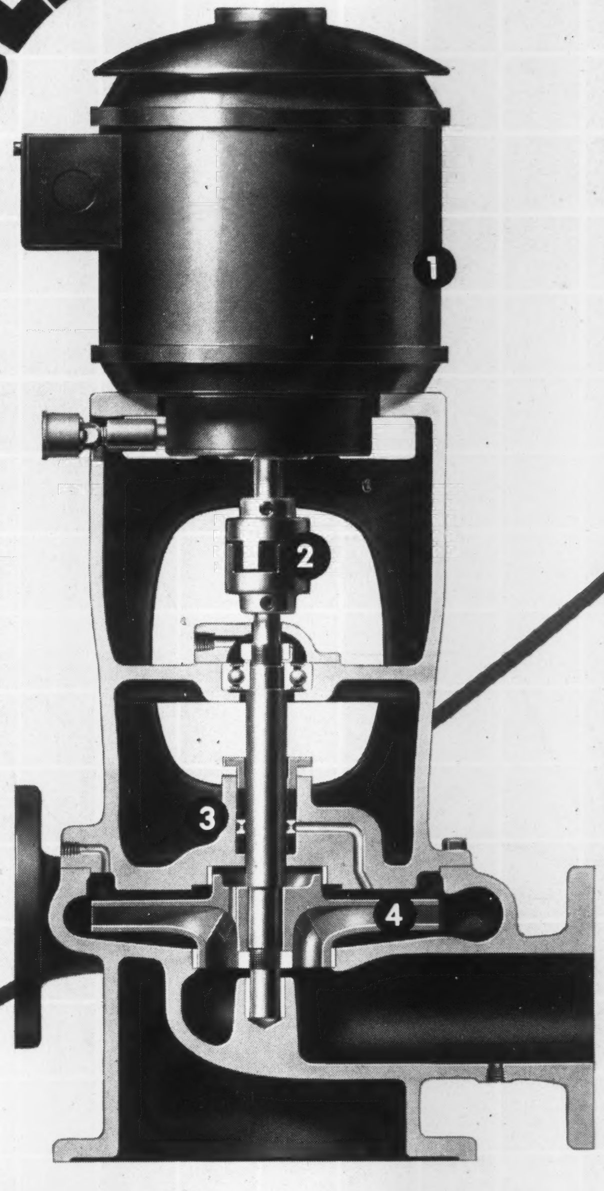
THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

VERTICAL CLEAR LIQUID PUMP

gives

BIG CAPACITY

... in a small space



Here's a real improvement in centrifugal pump design. A pump of larger capacity, full efficiency and adaptable to almost any job where clear water or liquids are handled. Easy to install where floor space is limited. It's the answer to the modern cry for elimination of excess bulk and weight with correspondingly lower maintenance cost.

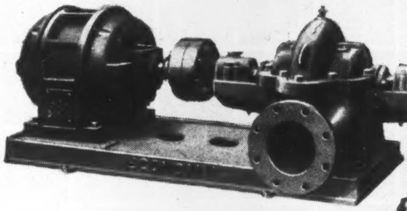
1 **HIGH MOTOR MOUNTING**—above floor splash and dirt.

2 **FLEXIBLE COUPLING**—accessible stuffing box.

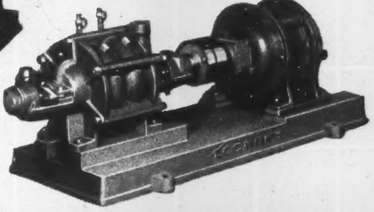
3 **ACCESSIBILITY**—complete rotor removable without breaking pipe connections.

4 **SMOOTH OPERATION**—impeller spins between two bearings.

5 **STANDARD MOTOR**—avoids prolonged shutdown as any stock motor is usable.



Economy Double Suction Pumps for clear liquid pumping in the larger service requirements. In a large range of sizes for services from 300 to 1200 G P.M. with heads up to 100 feet.



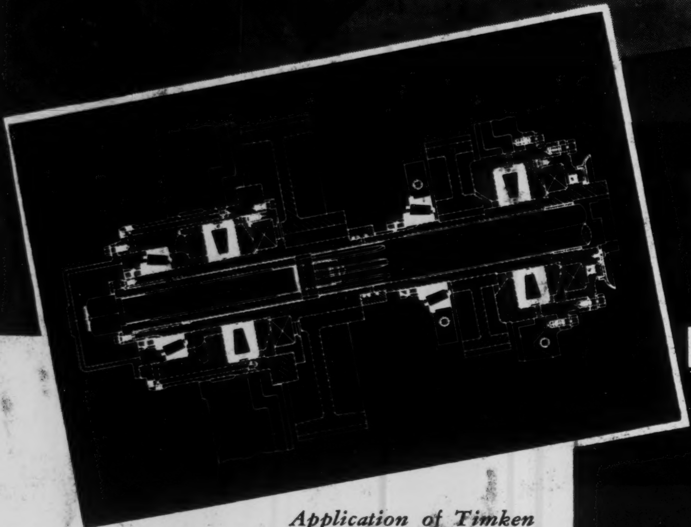
Economy Multi-Stage Pumps for pressure pumping—for services from 10 to 500 G.P.M. with heads up to 800 feet.

This improved design Economy Pump is made in several sizes with capacities from 10 to 500 G.P.M. and with heads up to 225 feet. Write today for illustrated catalog D2-1042. Also ask for Economy's latest Pump Data Book. Free to Plant Engineers and Executives.

ECONOMY PUMPS, Inc.

HAMILTON, OHIO, U. S. A.

Battery of French Mechanical Screw Presses extracting oil from soya beans at Archer-Daniels-Midland Company, Decatur, Illinois.



Application of Timken Bearings in French Mechanical Screw Presses.

TIMKEN BEARINGS
Control Thrust in
FRENCH MECHANICAL SCREW PRESSES

Carrying terrific thrust loads safely is the most important job for bearings in these modern oil extraction machines. So The French Oil Mill Machinery Company takes no chances; Timken Tapered Roller Bearings are used to carry the thrust from the feed worm and main shaft worms.

Average thrust conditions in any kind of equipment can be handled along with the radial loads by Timken standard and steep angle bearings. In these mechanical screw presses, however, the thrust is so severe that Timken Type T Bearings, designed to carry nothing but thrust load must be used.

These bearings not only take thrust with a wide margin of safety, but take it without a sign of friction, thereby effecting large savings of power and lubricant; increasing endurance and reducing maintenance. It pays to install Timken Type T Bearings where their use is indicated. The Timken Roller Bearing Company, Canton, Ohio.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS